DEVELOPMENT OF AN IMPLEMENTATION FRAMEWORK TO INTRODUCE INCENTIVE BASED DEMAND RESPONSE (IBDR) MANAGEMENT PROGRAM IN THE SUBSIDIZED ELECTRICITY DISTRIBUTION MARKET OF KUWAIT

By

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Rajeev Ramalloor Alasseri

14 March 2019

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Rajeev Ramalloor Alasseri

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EXECUTIVE SUMMARY

Increasing electricity consumption in Kuwait brought it into one of the top ten countries having high per capita electricity consumption in the world. By considering the extreme ambient conditions and the importance of electricity to ensure comfort during different seasons, the government provided subsidized pricing for of all the residents as part of its commitment to guarantee the well-being of everyone. On the other side, the government meets the growing demand by adding new fossil fuel-based power plants. This increased internal consumption of fossil fuel is a matter of concern as the country’s economy highly depends on the fuel export. In addition to that, subsidized pricing also brings an extra financial burden on the government. This opportunity loss of revenue opens the door for research to find out appropriate methods to reduce electricity consumption so that more fossil fuels can be saved, in addition to saving the budget for electricity subsidy.

To find out a suitable solution for the abovementioned business problem, a detailed literature review was carried out on eight different themes. The funneling down approach of literature review stressed on the importance of various demand response possibilities, which finally concentrated on incentive-based demand response (IBDR) programs. In connection with the IBDR programs, two major research gaps were identified. Firstly, no study could be found that addressed the IBDR feasibilities in a subsidized electricity market such as Kuwait. Secondly, the acceptance of various IBDR programs among the consumers in Kuwait’s residential sector was not explored so far. The final research gaps suggested focusing on different aspects of introducing suitable IBDR programs in the residential sector of Kuwait to control the increasing electricity consumption in the country.

While looking for the theoretical background of the study, it was learned that incentive theory of motivation (ITM) is precious for the current research. ITM deals with human motivation, and the backbone of IBDR programs is also

consumer motivation. The application of ITM while designing the programs was found to be useful to cover various aspects of consumer motivation. Even though ITM efficiently contributed to areas such as workforce, business, education, communication, etc., no comprehensive study was found, which utilized this theory in formulating electricity conservation (EC) programs. By using the ITM in the current study for formulating the IBDR programs, the results also contributed to strengthening the theory by adding ITM's coverage in subsidized electricity markets.

By combining both research and theoretical gaps, a research problem was formulated, which addressed how to motivate consumers through incentivization in a highly subsidized monopoly market. Accordingly, two research objectives were formulated such as "to develop an implementation framework to introduce IBDR programs in Kuwait's electricity sector" and "to study the acceptance of different IBDR programs by the consumers of Kuwait's residential sector." A well-known qualitative analysis methodology based on framework analysis followed by grounded theory based coding were used as the research methodology for the first objective. This two-stage methodology included document analysis and experts' interview, by which answers to the general questions for implementing IBDR programs in any new market were gathered and validated.

Using ATLAS.ti software, axial coding, selective coding, and theoretical coding of the collected documents and interview responses were carried out. By completing the first objective, a clear framework for implementing new IBDR programs was designed to suite Kuwait's electricity market. To check the acceptance of IBDR programs among residential consumers, three different IBDR programs, namely, remote controlling of selected load, summer vacation program, and quick bidding program, were suggested. Four different incentive schemes, such as cash refund, special service counter, lottery draw and special recognition, and special discount for energy efficient appliances and solar panels, were suggested for the newly designed IBDR programs. The response to the designed programs from the residential consumers of Kuwait was analyzed to check the acceptance of such programs in the subsidized market of Kuwait. Data were analyzed after gathering information through a well-prepared questionnaire, which covered different aspects of consumers such as demographics, response to programs on different time frames and incentives, and general feedback.

The analyzed results supported that all of the suggested IBDR programs can positively influence consumers for reducing their electricity consumption. Chi-Square test rejected the null hypothesis and established an association between incentivization and EC. Among the three suggested programs, most of the consumers preferred summer vacation program. Likewise, among the four incentive schemes, the majority of the consumers favored cash refund as the best option. Even though consumers are more attracted to monetary incentive (MI), they are interested in nonmonetary incentives (NMIs) also. It was also noticed that the change in the incentive scheme has no influence on the willingness to participate among the group of consumers.

The study results reveal that even in a subsidized market, people can be motivated by offering both MI and NMIs. However, several barriers, such as fear, unwillingness, and indifference, are expected from the consumers' side. To an extent, this can be overcome by introducing appropriate enablers such as ease, quality, aid, adequacy, awareness, customization, interaction, and demonstration.

As far as Kuwait's subsidized electricity market is concerned, at the outset, the government should develop appropriate policies for IBDR programs. The government can also support the programs by providing sufficient financial support. Prior to the design and implementation of any IBDR programs, minimum infrastructure has to be developed, which includes smart meters and two-way communication systems. In addition to the existing utility provider, third parties, including aggregators, can be considered for implementing the suggested programs. Proper awareness has to be given to different consumers prior to enrolling them in the programs. Other pre-requirements include the availability of trained manpower and measurement and verification facilities to carry out appropriate installation and maintenance activities.

LIST OF ABBREVIATIONS

AC	air-conditioning
BAS	building automation system
CBL	customer baseline
CM	corrective maintenance
CP	credit point
CPP	critical peak pricing
CRF	cash refund
DA	day-ahead
DARTP	day-ahead real-time pricing
DLC	direct load control
DR	demand response
DSM	demand-side management
EC	electricity conservation
EE	energy efficiency
ERCOT	Electric Reliability Council of Texas
ESCO	energy service companies
ESS	energy storage system
EU	European Union
FERC	Federal Energy Regulatory Commission
GCC	Gulf Cooperation Council
GDP	gross domestic product
GHG	greenhouse gas
IBCS	Internet-based communication systems
IBDR	incentive-based demand response
IBDRP	incentive-based demand response program
ICT	integrated computer technology
IHD	in-house displays
IL	interruptible load
ISO	independent system operator
ITM	incentive theory of motivation

KD	Kuwait Dinar (1 KD= US $3.33)
KES	Kuwait's electricity sector
KISR	Kuwait Institute for Scientific Research
KRS	Kuwait's residential sector
kWh	kilowatt-hour
LDSR	lottery draw and special recognition
LSE	load-serving entity
M&V	measurement and verification
ME	Middle East
MENA	Middle East and North Africa
MEW	Ministry of Electricity and Water
MI	monetary incentive
NMI	nonmonetary incentive
OOL	on/off loads
PBDRP	price-based demand response programs
PCE	per capita CO_2 emission
PCT	pre-closing treatment
PEC	per capita electricity consumption
PJM	Pennsylvania-New Jersey-Maryland Interconnection
PM	preventive maintenance
PTR	peak time rebates
PTS	programmable thermostat
QBP	quick bidding program
RCSL	remote controlling of selected load
RE	renewable energy
RES	renewable energy sources
RTP	real-time pricing
SDASP	special discount for energy efficient appliances and solar panels
SM	smart meter
SPSS	statistical package for the social sciences
SR	spinning reserves
SSC	special service counter

SSM	supply-side management
SVP	summer vacation program
TCL	thermostatically controlled loads
TDC	time-of-day control
TOU	time-of-use
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
USD	US Dollar
WH	water heater

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1. INTRODUCTION

1.1. Introduction

Even though Kuwait is not a highly industrialized country, its per capita electricity consumption (PEC) and per capita CO_2 emission (PCE) are listed among those of the top ten countries in the world. The researcher wanted to explore the fundamental reasons behind the high PEC in Kuwait and put forward an appropriate solution for improving the contemporary situation by reducing the electricity consumption. Additionally, he wanted to find out the acceptance of different suggested programs in the residential sector of Kuwait, the major electricity consumer in the nation. This chapter outlines the background, grand transition in power demand in Asian countries, and electricity conservation (EC) through demand-side management (DSM), as these are important as the basement for this research.

1.2. Background

The economic, social, and industrial growth of the world population is highly interlinked with the energy usage. The electricity consumption growth projected by the International Energy Outlook 2013 [1] is very distressing, as it has estimated 54% increase in electricity consumption between 2010 and 2040. According to this projection, the worldwide use of petroleum and other liquid fuels will reach 115 million barrels per day in 2040, against that of 87 million barrels in 2010 [1]. This increase in the energy demand causes worldwide concern not only on the depletion of nonrenewable energy sources but also on the growth in the greenhouse gas (GHG) emissions, which will lead to climate change and other environmental damages. In view of the above, it is the responsibility of all countries to lower the utilization of fossil fuel and hence reduce the GHG emission. The challenges will be high for countries using fossil fuels for electricity production, and hence the importance of EC is highly significant in such countries.

As balancing electricity production and consumption is a challenging task, many countries find an alternative by providing additional reserve capacity. To meet the future requirements, many utility companies were forced to invest a lot to increase their production capacity. The growing awareness among the people and decision makers on the environmental issues compel utility companies to look for alternate low carbon emitting solutions such as renewable energy (RE) sources instead of traditional fossil fuel-based power plants. However, the popular renewable energy sources (RES), such as wind and solar-based power plants, are not entirely dependable to make an electricity balance in the grid due to their variable power production capacity [2]. Additionally, the high cost and low efficiency of RE plants also keep the utility companies away from this option. Many countries have nuclear power plants to meet the growing demand as a substitute to fossil fuel-based power plants, which provide very stable power compared to wind and solar-based power plants. However, the past disasters in Three Mile Islands in 1979, Chernobyl in 1986, followed by the recent one at Fukushima Nuclear Power Plant in 2011, made many governments rethink on their nuclear policies [3].

In addition to adding new power plants to meet the growing demand, many governments and utility companies focus on different other methods such as improving the efficiency of power plants, reducing transmission and distribution losses, storing energy, and upgrading infrastructure to the smart grid to integrate distributed mini RE units.

1.3. Grand transition in power demand in Asian countries

According to the latest studies, between 2040 and 2050, Asia will surpass the combined power demand of North America and Europe. This prediction was made based on the gross domestic product (GDP), population, military expenses, education, health, governance, and technological investment. Emerging economies in Asia, such as India, China, and countries in the Middle East (ME), are making substantial investments in infrastructure development, which demands a lot of electricity [4]. Globally, the different sectors such as, residential, commercial, industrial, agriculture, and transportation are the major users of energy. However, the energy usage pattern of these users has been so far mostly irrepressible and inflexible with respect to the generation and distribution system.

1.4. Electricity conservation through demand-side management

Energy use in any part of the world is profoundly influenced by the climatic, social, economic, and cultural state of affairs. As energy is an important input for the social and economic growth of any nation, the energy demand has an unwavering relationship with proliferation in population and industrial activities. Due to the upsurge in the energy consumption, energy management is imperative for future economic steadiness and environmental safety. It is essential to have an equilibrium between the electricity supply and demand to attain grid stability. Many of the energy surplus countries follow supply additions to meet the increase in demand. They keep standby power plants to meet the peak power demand, which may happen for a few hours in a year. In most of the cases, low efficient power plants are assigned for this purpose. Due to the increase in the negative environmental impact of using fossil fuels, alternate methods are under continuous investigation to save our environment and climate. These practices not only help the nations improve their image in front of the international community but also help the oil-rich countries generate revenue reducing their internal consumption and by exporting the saved fuel for further revenue generation.

Promoting less usage of electricity, as a better option than building new power plants, was introduced by Amory Lovins in 1989 with a still discussed term “negawatt” [5]. Any decrease in the power demand is equivalent to the generation of a similar quantity of electricity. In fact, the impact will be more while considering the loss in the network.

A load management program developed by Clark Gellings (Electric Power Research Institute, USA) in 1984 is the base of the DSM evolution [5]. During the last few decades, the expansion of DSM took place in the United States of America (USA) at a fast pace, which was followed by other markets. DSM, which was started as a solution to reduce its dependency on oil import for power generation, reached a means of advanced economic growth now. In the beginning, the DSM programs were focused on the creation of awareness among consumers in various aspects such as the usage of efficient appliances, construction materials, etc. As the savings were low, the activities slowly progressed to areas such as energy audits and load shifting [6]. In the mid-90s, more consumer-focused events were introduced, which included cash rebates and low interest-based financial supports, to encourage using energy efficient appliances and materials [5]. The DSM strategies that were limited to energy efficiency (EE) related activities have grown in different directions, including consumer-focused demand response (DR) programs, and currently, many plans are introduced to decrease electricity consumption. Identifying the potential of DSM, the international community recognized DSM as a low-hanging fruit [7] to meet the growing electricity demand.

By the proper implementation of different DR programs, an impressive reduction of 28798 MW and 28934 MW was estimated for 2013 and 2014, respectively, in the USA, which is equivalent to a reduction of around 6% in its peak power [8]. The abovementioned observation from the USA explores the opportunities of using DSM as a method for meeting the peak power demand against the conventional supply-side management (SSM)-based solutions.

The Federal Energy Regulatory Commission (FERC) classified DR into price-based demand response programs (PBDRP) and incentive-based demand response programs (IBDRP). These two programs function in different ways. In PBDRP, the price of electricity varies with time, while in IBDRP, consumers are motivated by giving incentives for reducing consumption.

1.5. Organization of the thesis

The thesis is arranged in the following way. Chapter 2 provides more insight into the Kuwait’s electricity scenario, followed by a detailed literature review on different themes in Chapter 3. Chapter 4 dedicated to the theoretical premise of this research study, while Chapter 5 and 6 explain the research methodology, and results and discussions, respectively. Chapter 7 focuses on the policy assessment for introducing incentive-based demand response (IBDR) programs. The last two chapters are concentrated on limitations and future works (Chapter 8) and conclusions (Chapter 9). These chapters are followed by a bibliography and appendices. In the end, the author's brief profile is also added.

1.6. Summary

Worldwide consumption of electricity is anticipated to increase, and a significant share is predicted from the Asian countries including countries in the ME. Kuwait, an ME country, which meets its growing electricity demand by fossil fuel supported SSM, needs to focus on alternate methods, such as DSM and DR, to balance the environmental regulations.

The next chapter is dedicated to Kuwait's electricity scenario, for explaining its current ranking of PEC and PCE, reasons behind the high PEC, and the need for a study in this subject.

2. KUWAIT'S ELECTRICITY SCENARIO

2.1. Introduction

Since Kuwait is one of the countries holding the highest PEC in the world and is also a part of the Asian countries whose power demand is expected to increase drastically, this study was planned to be conducted in the electricity sector of Kuwait. To start with, it was necessary to get a general idea about the electricity market of Kuwait and the amount of work done in the direction of EC. This chapter focuses on the Kuwait's Electricity Sector (KES) and the motivation to conduct a DR-based study in this market.

2.2. Kuwait's electricity sector

The richness of Kuwait's economy is based on the ample reserves of fossil fuels and depends heavily on its exports. Approximately, 50% of GDP, 95% of exports, and 80% of government income are reliant on oil. To satisfy the growing local demand, Kuwait consumes around 24% of its natural resources [1], which keeps on increasing year by year. As all power plants run with fossil fuels, 46% of the internal consumption is used only for electricity production [9]. Growth in PEC and population plays a vital role in the hastened rise in the electricity consumption of the country. From 2000 to 2014, an average annual growth of 6.9% in PEC was observed, which was higher than the population average growth rate of 3.8% [9].

Referring to the PEC data published by the World Bank [10], Kuwait stands at the fourth position, leaving highly industrialized countries, like the USA, far behind (Fig. 2.1). Kuwait's PEC for the year 2012 was estimated as 14,054 kilowatt-hour (kWh), i.e., 3.1% higher than the previous year [9]. The main argument for the high PEC is the geographical location and climatic conditions of Kuwait, where air-conditioning (AC) is not a luxury but a necessity for almost ten months in a year. However, while comparing the PEC of Kuwait to that of countries having similar geographical and climatic conditions, it is challenging to justify the argument [10].

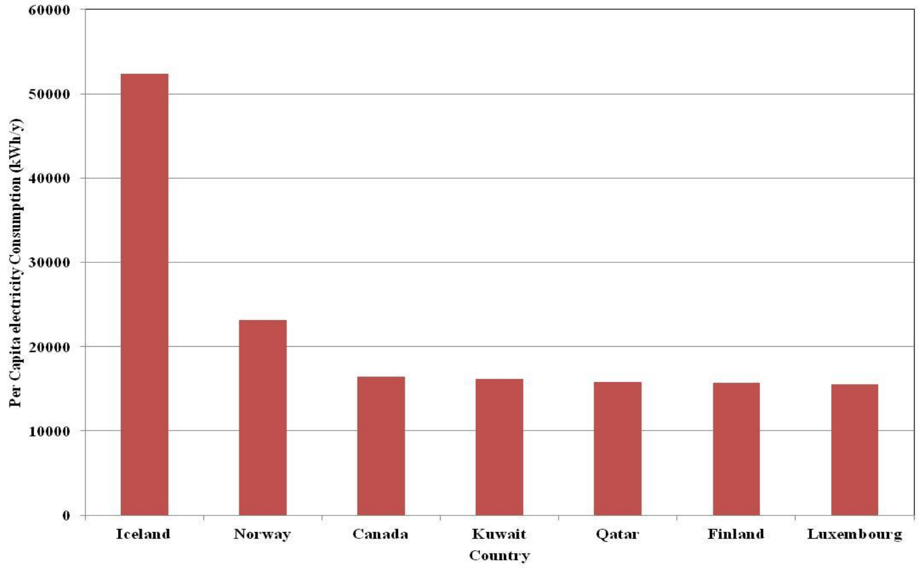

Fig. 2.1. Top seven countries having the highest per capita electricity consumption

Similar to PEC, Kuwait stands third in the PCE also [11] (Fig. 2.2). Electricity generation has a major share in GHG emission as Kuwait emits 870 g of CO_2 for producing 1 kWh of electricity, which is 50% higher than the world average of 570 g of CO_2 [11]. At present, in Kuwait, any increase in electricity demand is met by introducing new power plants (Fig. 2.3), which worsens the environmental conditions. The real peak demand in an electrical system occurs for a few hours in a day for some selected days in a year. From Kuwait's monthly peak power demand (Fig. 2.4) for the year 2013 [9], it is evident that peak power demand in July is almost double of that in February.

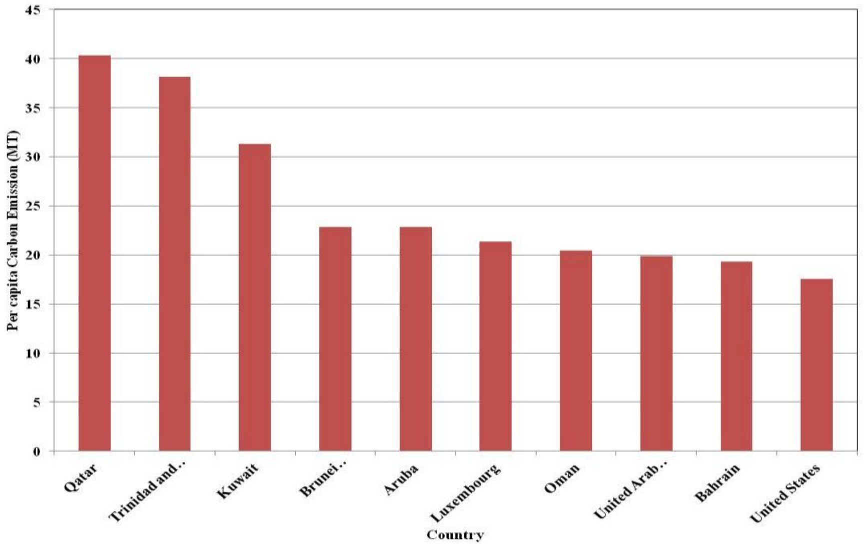

Fig. 2.2. Top ten countries having the highest per capita CO_2 emission

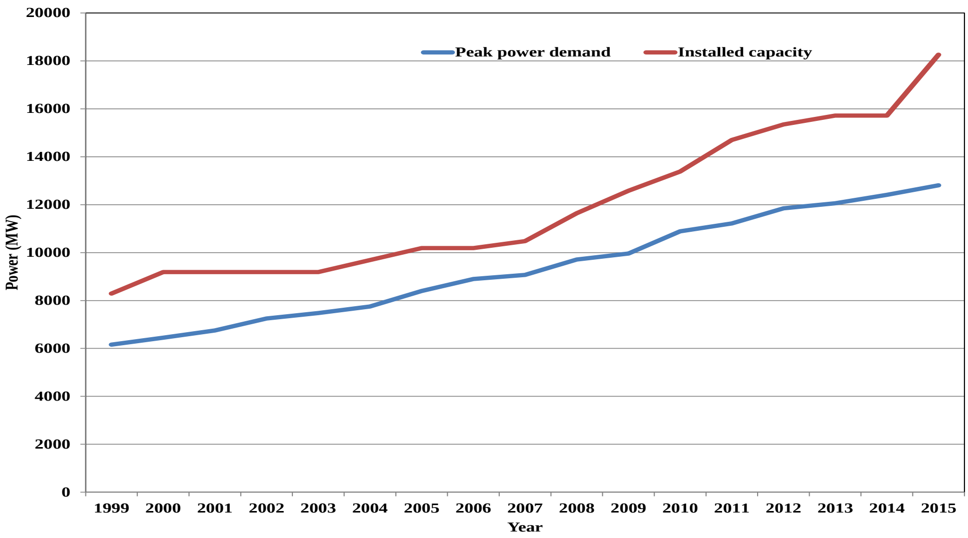

Fig. 2.3. Capacity addition to meet peak power demand in Kuwait

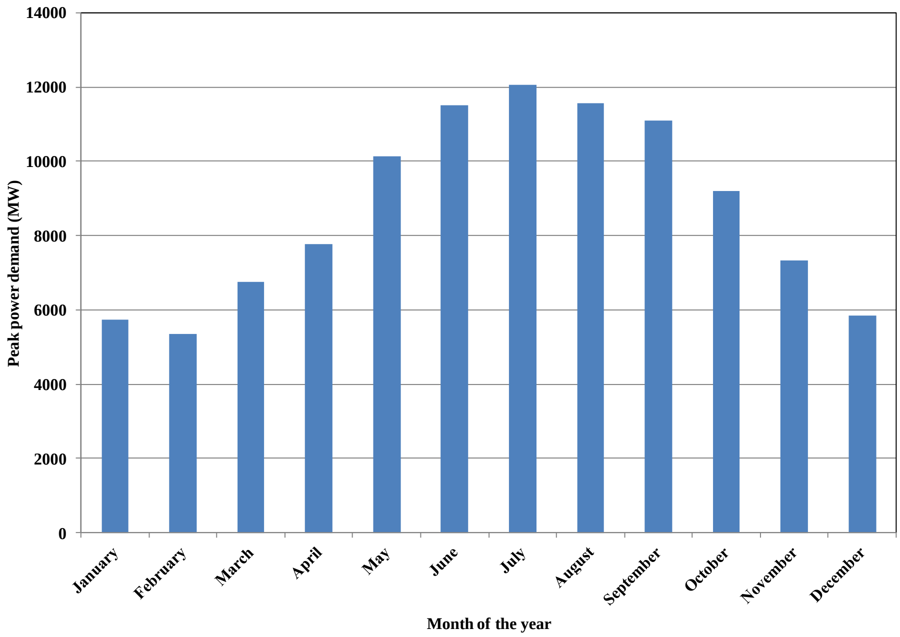

Fig. 2.4. Monthly peak power demand in 2013

Electrical energy is highly subsidized in Kuwait. The rate of electricity per 1 kWh has remained Kuwait Dinar (KD) 0.002 (i.e., US$0.0066) for more than 50 years, while the actual production cost is around KD0.034 (i.e., US$0.112) [12]. The comparison of Kuwait's electricity price with that of some selected countries is presented in Fig. 2.5 [9,13].

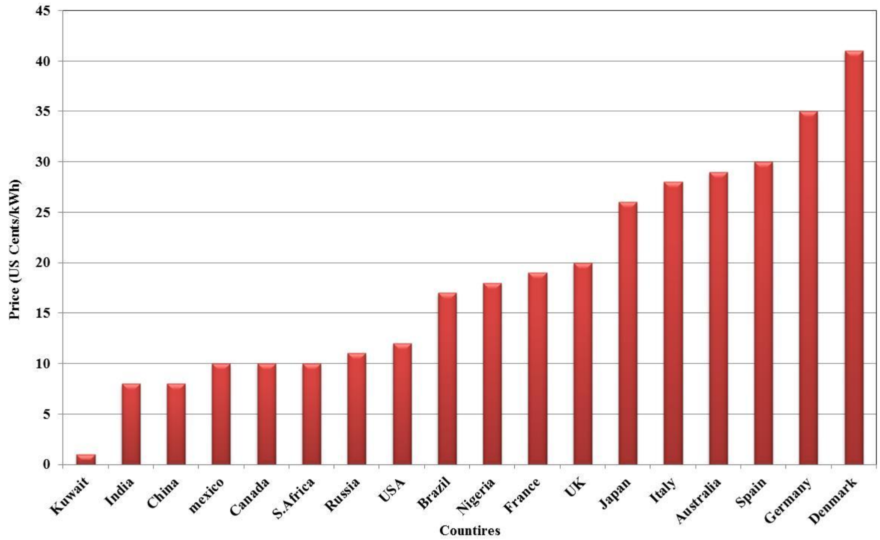

Fig. 2.5. Electricity price in selected countries [13]

2.3. Recent studies related to Kuwait’s electricity sector

Many studies conducted in the countries of the Middle East and North Africa (MENA) region [14] and Gulf Cooperation Council (GCC) [15] expressed the concern on the low EE and need for energy conservation policies. Along with cultural barriers and low awareness among the residents, subsidized pricing is identified as a significant obstacle for promoting sustainability in this region [16].

Improvement in living standards due to Kuwait’s economic development during the last few decades, unrestricted availability of electrical power and energy at highly subsidized rates [17,18], and lack of awareness among the residents made Kuwait’s PEC one of the uppermost in the world. Besides the massive subsidy given to domestic consumption, the poor efficiency of some of the older power plants contributes well to the increase in the fossil fuel consumption in Kuwait [19]. In addition to the outdated infrastructure and lack of incentives to promote energy conservation, increase in both expatriate and local population and their fascination for modern electricity driven gadgets also contributes to the high energy consumption in the country [20].

High electricity-intensive water desalination is one of the leading contributors to electricity consumption in the country. After comparing five different desalination and cogeneration technologies, as an alternative to high electricity-intensive water desalination, [21] recommended having natural gas-based reverse osmosis plants as a more cost-effective option for water production in Kuwait. By highlighting some inefficiencies of electricity and water production, in their two-part report, authors [22,23] suggested different suitable energy conservation options implemented in other countries.

The importance of restructuring Kuwait’s Electrical Power System was discussed by [24]. Even though the results indicate that these reforms cannot be carried out in short-term or mid-term future, it identified the scope for a healthy sustainable energy business in Kuwait. High, base, and low oil price related demand behavior model was generated by [25] to forecast power demand, with an assumption that the socioeconomic condition of Kuwait will remain the same until 2030. After compiling the historical and future energy situations by focusing on the highest consumer of fossil fuel, the power sector, [26] discussed different aspects of production, alternate electricity source, and electricity usage in the country and emphasized the importance of energy conservation.

Kuwait Government's research institute, the Kuwait Institute for Scientific Research (KISR), conducted many studies in the field of EE and, in one of its reports [27], recommended to do energy auditing in buildings and suggested some methods to save electricity without much investment. Peak power demand occurs in Kuwait for a few days in summer due to high AC usage because of extreme ambient temperature [17]. Peak power reduction was one of the targeted areas of research of KISR, and by modifying the operational strategies, a reasonable reduction in peak power consumption in governmental and institutional buildings was achieved [28]. This demonstrates the hidden opportunities in the field of energy conservation in Kuwait. In one of the studies done by KISR [29], it managed the operation of AC and other electrical equipment in different governmental buildings using centralized building automation system (BAS). However, the success in formulating energy conservation policies is ultimately a government's function [30,31]. The abovementioned studies emphasized the importance of addressing the wastage of energy in the country and to suggest suitable solutions for the same.

2.4. Opportunity loss of revenue

Experts indicate that Kuwait is missing a considerable amount of revenue by using oil for its electricity production, which is not utilized efficiently, instead of selling it in the international market [32]. This highlights the hidden opportunity loss in the electricity sector.

According to Energy Information Administration, 0.00175 barrels of oil are required to produce 1 kWh of electricity [1]. By considering the oil price as

US Dollar (USD) 55 per barrel, by saving 1 MWh of electricity, a direct savings of USD 96.25 can be achieved from the saved oil and a significant savings of USD 173.25 from the subsidy given to consumers on their electricity price. Also, this will help in reducing 870 kg of CO_2 emission [11].

The annual electricity consumption of Kuwait for the year 2013 was 53584 MWh [33]. KISR explored the opportunities of power reduction in major sectors of Kuwait, ranging from 15% to 25% [29]. A 10% reduction of the electricity consumption, which is 5358 MWh can save USD 0.5 million from oil price and USD 0.8 million from the subsidy. Additionally, a 4660 carbon credits will further contribute a savings of USD 0.14 million [34].

In summary, by reducing the yearly electricity consumption by 10%, USD 1.45 million will be saved. This opportunity loss will vary directly with the load reduction. By looking into the massive opportunity loss, the following business problem is derived, which needs to be addressed.

2.5. Business problem

Nonoptimal consumption of electricity due to subsidized pricing is leading to opportunity loss of revenue.

2.6. Motivation/need for the research

It is obvious that any attempt to reduce the electricity consumption in Kuwait will be useful to reduce its electricity production and hence the PEC, which will eventually reduce the GHG emissions. Moreover, being an oil exporting country, Kuwait can export the saved oil, which can bring more revenue to strengthen the economy further. The hidden opportunity of reducing the electricity consumption in Kuwait motivated the researcher to explore different possible ways of achieving the power reduction and to suggest the most feasible solution for improving the country’s economic and social status.

2.7. Summary

Increasing electricity consumption in Kuwait brought it into one of the top ten countries having high PEC in the world. By considering the extreme ambient condition and the importance of electricity to ensure comfort during this period, the government provided subsidized pricing for all of the residents as part of its commitment to guarantee the well-being of all. On the other side, the government is meeting the growing demand by adding new fossil fuel-based power plants. This increased internal consumption of fossil fuel is a matter of concern as the country's economy highly depends on the fuel export. As a result of reducing the electricity generation by controlling its consumption, the country can save the fuel used in power plants, which can be exported. In addition to that, significant amount spent by the government for the subsidy can also be saved. This opportunity loss of revenue opens the door for research to find out the most appropriate method to reduce electricity consumption so that more fossil fuel can be saved, in addition to the saving of the budget for electricity subsidy.

From the referred literature, it was learned that, even though a lot of work was carried out in Kuwait related to EE, a central component of DSM, the feasibilities of implementing the other element of DSM named DR is not yet addressed adequately.

To find out a suitable solution to the business problem, a detailed literature review was carried out. Initially, the literature review was carried out on the themes that were directly derived from the business problem and then funneled down to other few more topics. A detailed literature review is presented in the next chapter, covering all of the associated aspects.

3. LITERATURE REVIEW

3.1. Introduction

A literature review is useful to understand the topic thoroughly. This methodical, categorical, and reproducible method of finding, assessing, and synthesizing the prevailing information on finalized work logged by researchers and scholars will not only direct to determine the amount of work already been carried out and what remains to be explored but also help to restrict researchers by giving valuable insights into those methods that are not appropriate for investigation [35].

In this study, the initial document collection was carried out based on the focused areas suggested by the business problem. Accordingly, as a first step, three themes were identified such as “the impact of EC on economy and environment”, “EC policies and planning”, and “electricity subsidy”. As the business problem focuses on the nonoptimal use of electricity as the root cause, it was decided to check the positive and negative influence of EC on economy and environment as the first theme. After ensuring the suitability of EC, the literature survey was concentrated on the second theme named “EC policies and planning” to explore the different methodologies adopted in various markets related to EC. In parallel to these, information related to electricity subsidy was also gathered.

The documents were collected from the top research databases such as ScienceDirect, Scopus, Web of Science, JSTOR, and Google Scholar. Reports of different commercial companies were also gathered by conducting multiple Google searches. Snowball sampling method was adopted for adding new materials, in which documents were selected from the reference lists of the referred papers [36]. Reports of peers were collected in cases where references were not available. Document collection continued until no more new materials could be identified, which have a substantial relationship to the business problem.

A popular literature review approach, funnel method, was adopted for this study. As per this method, the flow of review process follows the path of a funnel [37]. The width of the funnel varies according to the identified groups/themes and documents collected in the initial stage, while the depth varies with the specialization of subjects. At the end of the funneling process, the answers to the business problems are expected to be formulated.

There is a well-established connection between a country's electricity consumption and its GDP and contribution to environmental conditions. The first theme of the literature survey focuses on the different studies conducted on this theme in various electricity sectors.

3.2. Impact of electricity conservation on economy and environment

A positive relationship was claimed between GHG emissions and GDP in fifteen European Union (EU) countries by [38]. They also went into detail on the type of nonrenewable fuels and identified that solid fuels have a negative impact on GDP, while petroleum fuel has a positive one. The impact of CO_2 emissions based on renewable and nonrenewable energy in Organization for Economic Cooperation and Development countries was studied by [39], and they came out with a lot of suggestions to increase the use of RE to have an adverse impact on CO_2 emission and a positive impact on GDP. [40] inspected the matching of optimal EE policies, and regulatory DSM tests and results were used to assess tests in the 2002 California Standard Practice Manual for assessing DSM programs. A model of integrated resource strategic planning was proposed with a unified smart grid to utilize more RE into the grids and apply DSM to achieve China's low carbon targets in a long-term perspective [41]. Additionally, [42] estimated the association between GDP and electricity consumption for ten newly developing Asian countries and reported long-run relationship in both directions and unidirectional causality in the short-run.

Environmental Kuznets Curve hypothesis for the MENA region for CO_2 was run by [43]. The results say that long-run energy consumption has a substantial influence on CO_2 emission, and real GDP has a quadratic association with CO_2. They also pointed out that at the macro level, economic growth in MENA countries will not affect environmental degradation. In a study on 17 MENA countries by [14], they tried to establish the relationship between economic growth and carbon-friendly policies and stressed the importance of carbon-friendly practices. Recent work to explore the appropriateness of energy conservation policies in GCC countries by [15] opened a prominent platform to ponder over the effect of EC on GDP in different GCC countries. They found a bidirectional relationship between fossil fuel consumption for electricity generation and GDP in the United Arab Emirates (UAE) and Bahrain, while one-way relationship in Oman and Qatar. It is very much encouraging to note that, they could not find any relationship in Kuwait and Saudi Arabia. Based on this, [44] studied the scenario in Bahrain and argued that economic growth and electricity consumption are positively correlated. However, these results are contradictory to the results presented by [18], in which author predicted the unidirectional relationship between electricity consumption and GDP for all GCC countries. There are other studies reported in this field to find out the connection between electricity consumption and GDP in 22 developing countries, 18 developed countries, and GCC countries, respectively [45,46] and the authors recommended to practice energy conservation policies and promote RE. Four main hypotheses (conservation, growth, neutrality, and feedback) were tested relating to electricity consumption and GDP for different countries and [47] reported maximum results favoring neutrality hypothesis.

The lack of incentives for the investors is identified as the main reason for the low participation of the private sector and considered to be the main barrier for deploying RE in GCC countries [48]. A correlation between average electricity price for some industrial users' real-time pricing (RTP) tariff and their consumption of wind-generated power was established [49]. Authors urge industrial consumers to increase the share of wind energy to get rid of the RTP issues during peak hours. Different possible evolutions for meeting the electricity demand, such as the addition of new generation capacity, electricity production by source, and the automation of the domestic equipment, were discussed by [50]. Authors [51] predicted the economic benefits that can be attained by providing tertiary reserve capacity with RE in industrial processes. Also, the role of innovative devices in the DSM was explored [52].

Economic analysis of the clean energy option for Kuwait was conducted by [53]. In their study, they included different combinations of fossil fuel, RE, and nuclear energy-based power generation, and recommended strategies for promoting RE in Kuwait. By using ten years' historical data of GDP, income from oil, population, electrical load, and water demand, [25] developed a country specific electricity and water demand model and argued that there is a strong relationship between electric power, population, and GDP.

By seeing the importance of EC and its positive impact on the environment and economic conditions of various countries, various EC policies and planning practiced in the different parts of the world are discussed in the next section.

3.3. Electricity conservation policies and planning

The influence of cross-region transmission and peak regulation on China's low carbon electricity development until 2025 was estimated using upgraded IRSP-sgs model by [41]. They also identified the possible practices to determine costs and benefits as well. [54] tried to explore the energy security concerns among the general public in the United Kingdom (UK) and learned that energy security is only a developing concept within the society. Meanwhile, based on the study on the effect of rebate policies on the sales of ENERGY STAR labeled household appliances in the USA, [55] concluded that rebate policies increase the share of sales of ENERGY STAR household appliances by around 7.4%.

In the first outcome of the discussion group on DSM and EE of EU-GCC Clean Energy Network, [56] recommended a lot of policy and planning suggestions such as energy labeling for household electricity gadgets, redesigning of subsidy policy, promotion of EE campaign, the introduction of the smart meter (SM), etc. EU members are obliged to work toward achieving the EU environmental and energy objectives, and a study was conducted to explore how effectively DSM tools can be used by policymakers to achieve the given targets [57]. It is highly recommended to design effective policies and mechanisms to provide incentives for grid companies to restrain their motivation to sell more power to high-energy consuming industries [58]. Along with different DSM policies applied in various parts of the world, the author proposed how effectively systematic reviews can be used in the field of energy policy [59]. Top-down and bottom-up approaches available in different countries for energy policy modeling were well discussed by [60].

The power forecasting in countries like India is very challenging. Several factors, such as the financial growth of the people, weather condition, advancement of the technology, policy of a government, and global relation among countries, play an critical role in the power forecasting under the Indian scenario [61]. The electricity demand reduction could be improved by modifying the power production in thermoelectric power plants. The results provide a useful vision for the local planning body to lessen electricity demand and power-grid strain, particularly during peak hours in the summer [62].

A set of policy recommendations to stimulate RE deployment in GCC countries was formulated by [63]. They pointed out that, to increase the cost-effective installations of RE into the existing system, high-level collaboration between stakeholders and decisionmakers in the electricity sector is required. Some significant policies to reduce high-energy consumption in GCC countries were identified by [15]. They are now allocating more funds for energy saving, EE projects, increasing the role of RE, etc. A mixed integer linear programing model was prepared to aid in planning investment and policy decisions on desalination and cogeneration in Kuwait and used to minimize the net present value for the time duration of 2013–2050 [21].

The impact of fossil fuel prices, economic broadening policies, and energy preservation programs for Kuwait was reviewed by [17] in detail. They explained the impacts of oil revenue on government's policies toward economic developments and EE on the water and electricity needs. They argued that together with the absence of taxation, the level of subsidy removed the financial instruments usually used to promote efficiency and conservation.

While carrying out the literature review on the abovementioned two themes, many documents were found to be explaining the various aspects of electricity subsidy. All such documents were reviewed separately and consolidated under the subsequent theme, electricity subsidy.

3.4. Electricity subsidy

A simple efficiency subsidy modeling test was conducted by [40] to test the recommendations of 2002 California Standard Practice Manual and concluded that subsidies would be beneficial for EE. The impact of rebate policies was estimated using a difference-in-difference approach in the USA by [55], and they suggested that the usage of rebate policies for promoting ENERGY STAR equipment is a useful tool to promote EE in households. During the review discussion on the electricity market by the Electricity Market Review Steering Committee of Government of Western Australia [64], two alternatives were recommended to get rid of subsidy burden. However, this requires further intensive study and policy formation. [65] addressed the challenges faced by FERC due to subsidies, when regulating wholesale markets. The author concluded by saying, “The FERC has no magic wand to make subsidies disappear and, even where it has clear jurisdiction to act, it has the limited political capacity to engage in recurring conflicts with the states.” The above statement of FERC [65] has great significance in the entire subsidized market, irrespective of the commodity.

A group of scholars from 28 EU countries studied the subsidies and costs in EU and tried to quantify the public interventions in energy markets [66]. They stated that the total subsidy in the member states for the energy demand was as high as 27 Billion Euro and added that it was challenging to continue subsidy in selected energy sectors.

Energetica India tried to gather experts’ opinion on subsidies in the electricity market [67]. According to the interviewed experts, a significant change is required to shift from state-run regulated distributed scenario to open-access practices. They also recommended phasing out cross-subsidy in a time-bound manner by following proper guidelines issued by the authority.

In GCC, the subsidized electricity price is considered as part of the social policy [31], and authors suggested replacing it with incentives of a different nature such as the establishment of public funds to purchase energy-efficient equipment, tax benefit for energy efficient investments, etc. In their recent study [16], a team focused on the public view on the sustainable houses in an electricity subsidized market such as Saudi Arabia, where the electricity consumption and CO_2 emissions are very high. Cultural barriers and low awareness among the residents are identified as some of the obstacles for promoting sustainable houses in this region.

Most of the documents referred as part of the literature survey for the abovementioned three themes were somehow related to DSM irrespective of their focused area. This funneled down to the importance of focusing more on the documents on DSM. Electricity meter installed by the utility provider makes a clear boundary between supply-side and demand-side. Any activity carried out to reduce electricity consumption after the meter, in the load side can be named as a DSM activity.

DSM is broadly divided into two major areas such as EE and DR. The primary objective of EE is to get the same work done with less electricity input. EE is more like a permanent type of implementation program as most of the EE methods are to be followed while constructing the building itself. This requires a lot of initial investment also. While DR is mostly used for shifting the load from peak time to lean period, and this involves a lot of participation and contribution from the consumer’s side.

As previous literature identified DSM as a useful tool to reduce electricity consumption, the next section concentrates on an overview of DSM and the latest developments in DSM in different part of the world.

3.5. Demand-side management

DSM is a well-established solution for energy management, and by optimally implementing it, end users' energy resources, as well as energy demand profiles, can be managed efficiently. It can be said that a proper DSM implementation is equivalent to a "virtual power plant." DSM aims to change the load shape according to the simultaneous availability of electricity in the grid, by influencing the usage pattern of consumers [68].

A review of the DSM policies in the UK, since the energy crisis in 1970, was carried out by [5]. After checking the influence of the EU instructions on UK's electricity market, [5] concluded that without regulatory policies and financial support, DSM has a minimal role to play in any country. While discussing the major benefits and challenges of DSM in the UK context, [69] addressed different areas such as drivers for introducing DSM, benefits and future opportunities, various DSM technologies, etc. Several aspects related to DSM, to meet European environmental and energy goals were explored by [57]. In addition to recommending DSM for improving energy and environmental efficiency, [57] suggested having country-specific DSM models developed based on the explicit production mix in any given country. In one of the investment-oriented study, [51] explored the future usage of DSM in Germany and its effect on investments in the electricity markets.

[70] carried out a comprehensive study of possible DSM methods for Nepal and commented that most of the proven DSM programs are financially feasible for Nepal. Additionally, [70] identified the most cost-effective areas for the residential and commercial sector, as power factor optimization, the use of energy-efficient lighting, and retrofitting of industrial induction motors with intelligent motor controllers. Other widely adopted methods include incorporation of RE [50], the interconnection of building energy systems [68], optimized usage of appliances, etc. [71].

A detailed literature review of optimization models and methods for the DSM of consumers in the residential sector was conducted by [72], and the main features of DSM methodologies were summarized based on optimization methods. By modeling DSM into supplier side and consumer side games, [73] investigated the effectiveness of DSM approaches on the daily load profile of consumers and the methods adopted by electricity companies to deal with such approaches in a smart grid system. A Vickrey-Clarke-Groves mechanism for DSM programs was proposed by [74] to encourage the efficient utilization of energy among consumers. Different ways to surmount problems related to implementation of DSM policies and the main reasons behind the failure of successful policies while transferring them between countries and regions were discussed by [59]. It is not necessary that a successful DSM policy in a particular country will be successful in other nations as well.

The ways to incorporate DSM while reforming the current Chinese electricity system was discussed by [58], and the author recommended that supporting system benefits charge will have a better effect than electricity price reforms. Finding revenue for the implementation of DSM is challenging in many cases. Different possibilities to meet the funding for DSM were explored by [75], and the author suggested many ways to generate funds such as setting up of special financial funds, implementation of system benefit charge, taking out of electricity price for DSM, etc., out of which system benefit charge is the most suitable method to give long-term steady and adequate financial support for DSM in China.

DSM implementation is very limited in India, and a large level execution plan requires covering many hurdles such as the introduction of proper regulation, the involvement of distribution companies, etc. A comprehensive methodology for executing a DSM program in India was outlined by [76]. This was done by keeping a target of ensuring mutual benefits for the utility provider and the customer. While evaluating the DSM implementation methods for India in a multi-objective way, [77] identified finding special funds and giving technical support to customers as the highly ranked strategies for the effective implementation of DSM. By inviting industrial experts, the Indian Institute of Technology, Bombay, arranged a platform to discuss the issues related to accelerating the necessary steps for the design, development, and implementation of large-scale DSM projects in India [78]. A representative group of 32 experts and officials from different state electricity boards, utility companies, energy service companies (ESCO), and academia attended the event. In the discussion, the experts emphasized on the points such as the need for a core group, the formation of a web portal for updating technological developments and case studies, gathering of more support from academics, etc. One of the challenges faced in the Indian electricity sector is the theft of electricity [79]. The presence of proper agencies is important to implement and evaluate different DSM policies [80].

The potential of energy saving using DSM in commercial, governmental and institutional sectors in Oman was estimated and the discounted payback between 4 and 12 years was reported by [81] for energy efficient equipment.

However, it is important to note that the influence of DSM programs in reducing the electricity consumption in Canada over the past two decades does not have a substantial improvement on the overall electricity consumption in Canada [82].

Kuwait is the first country to have an EE code focusing on building construction, equipment selection, and operation in the GCC region. The next section consolidates a detailed review of the latest developments in the EE from a management perceptive.

3.5.1. Energy efficiency

Kuwait introduced guidelines for building construction in 1983 [83] and is the pioneer in developing such codes in the region. This code is modified time to time to incorporate different advancements in the technology. This code specifies minimum resistance to walls and roofs, proper window-to-wall ratio, proper ventilation rates, energy-efficient equipment with specific power rating, etc. Based on the recommendations in the code, the Ministry of Electricity and Water (MEW) controls the maximum power connection to different buildings by restricting wattage per area. Accordingly, a building constructed based on the code will have the potential to save electricity, compared to the buildings which were built prior to the code implementation. Until 2009, financial benefit around USD 10 billion was achieved as a result of the proper application of the energy conservation code [30]. Additionally, optimized operation techniques developed by KISR were found to be very helpful in decreasing electrical power usage and peak power requirement [84], which in turn save millions of dollars as fuel cost, and capital and operational costs of power plants, in addition to the reduction in GHG emissions. The MEW updates the code at regular intervals [30], which reduced the electricity permit (wattage per area) to the buildings further down compared to its previous version. Considering the reports that mention the inadequate control on the operation of buildings in Kuwait [14], this section concentrates on some of the important EE operation practices adopted in Kuwait and around the world. Table 3.1 shows different EE policies adopted in GCC countries [56].

Without getting excellent support from end users, EE programs cannot be implemented efficiently. In 2006, the MEW faced some shortage to meet the peak power demand, and an awareness program named “Trsheed” was launched as a short-term solution to handle the issue [85]. The primary aim of this program was to increase the awareness of EE among the residents of Kuwait.

Some of the well-practiced techniques in the AC buildings are pre-closing treatment (PCT) and time-of-day control (TDC). In PCT, AC systems in the buildings will be closed an hour prior to occupants leaving the buildings, which merely affect the comfort of the occupants but significantly contribute toward peak power shaving [28]. In TDC, the air handling units and lighting systems will be operated to match the occupant’s availability in the building [30]. TDC and PCT were modified into an improved TDC and early reduction of cooling supply, respectively [86], and a considerable power decrease was achieved in the peak hours and non-occupancy hours. Most of the available BAS is capable of handling this task. While presenting the results of electricity savings by developing a centralized monitoring and demand management system for AC loads for schools and governmental institutions, where the AC runs 24 hours a day, [29] emphasized the importance of the proper utilization of BAS. Studies on EE are carried out globally, and some of the selected ones are listed subsequently.

Similar to PCT and TDC, some other DSM techniques, namely, global temperature adjustment, variable air volume system, and chilled water storage system for heating ventilation and AC were studied by [87], and their energy savings and load shifting capabilities were quantified.

An appliance commitment algorithm was developed by [88] to schedule appliances those are thermostatically controlled based on cost and usage forecasts and the authors claimed that the given solution offered an optimal balance between energy use and user comforts. A model-based feedback control technique, to control the power demand of thermostatically controlled loads (TCL) by manipulating a common offset in the advanced thermostats, was developed by [89]. [90] estimated the potential of DSM efficiency improvement in the short-term and long-term perspective for the Indian state of Gujarat and emphasized the usage of high-efficiency electrical equipment to improve EE. With the help of an analytical framework, [91] evaluated the economy-wide benefits that may result from the EE action plan in Thailand and quantified the expected savings in terms of financial and environmental benefits. [92] analyzed the cost-effectiveness of electric utility ratepayer-funded programs to promote EE investments and found that the current EE DSM expenses decrease electricity demand, and this result continues for some years. In a study on EE policy, program efforts, and outcomes, [93] commented that EE policy efforts had a positive relationship with electricity savings and noted that utility companies might achieve more savings if they invest more in preparing better policies.

Table 3.1. Different energy efficiency policies adopted in GCC countries

Country	Plan	Implementer	Concept
UAE	Urban master plan Abu Dhabi 2030	Abu Dhabi Urban Planning Council	Sustainability
UAE	The pearl rating System	Estidama	Sustainable development
UAE	Development of DSM strategy	The Economic Affairs Unit of Abu Dhabi	Electricity and water consumption
UAE	Dubai strategic plan 2015	Dubai government	Sustainable development
UAE	Energy efficiency label and standard scheme	Emirates Authority for Standardization and Metrology	Environmental impact
Kuwait	Code of practice for energy conservation	Ministry of Electricity and Water	Energy conservation
Saudi Arabia	Energy efficiency program	Ministry of Water and Electricity	DSM
Saudi Arabia	Energy labeling program	Saudi Arabian Standards Organization	Quality of imported electrical products
Qatar	Program to educate and increase awareness	Qatar Green Building Council	Green building
Qatar	National vision 2030	Ministry of development planning and statistics	Sustainable development
Oman	Energy conservation program	Electricity companies	DSM
Bahrain	Energy efficiency program	Electricity and Water Conservation Directorate	Energy conservation and DSM

As most of the EE related studies are already carried out in Kuwait, the focus was diverted to the less attended area, DR, which is implemented with the help of consumers. However, the effectiveness of DR depends heavily on the behavior pattern and commitment of consumers. The next section concentrates on the field of DR.

3.5.2. Demand response

The production cost of electricity varies from power plant to power plant due to the difference in efficiency and other related issues. In this way, the cost to generate 1 kWh of electricity varies continuously based on the power plants in operation [94]. Accordingly, utility companies offer varying electricity rates to their customers based on the fluctuating production cost. Generation companies should be well equipped to meet the peak power demand, which may happen only for a few hours in a year, and are forced to keep their generation facility capable of fulfilling it. Typically, the power plants, which are held for this purpose, will be the oldest among the group or the most inefficient one. This will elevate the overall electricity price for peak period [95], and ESCOs are forced to buy the electricity for a higher price, which will influence the electricity cost. It is a top priority for ESCOs to reduce the consumption during this critical peak period, and hence special agreements are made with customers. This will also help lessen the burden on the electrical network.

The FERC defines DR as “changes in electric use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized” [96].

Electricity rates appear to the end users as an average cost and may not reflect the changes in the production cost over the time [97]. DR is a program meant to motivate end users to change their electricity use when the production cost is high or the grid is overloaded. This is mainly achieved by either increasing the tariff or offering different types of incentives to end users. DR is mostly used for shifting the load from peak time to learn period. Any short-term implementation of DR can be named as capacity based, while the same for the medium term is called as energybased [98]. DR requires a lot of participation and contribution from the consumers’ side. Price reduction to consumers, reduction in transmission congestion, rescheduling of transmission and generation investments, etc., are identified as some of the significant advantages of the implementation of DR programs [99]. Incentives can be introduced to electricity distribution companies to ensure power quality and reasonable price for consumers [100]. While investigating the cost impacts of different DR programs, [101] presented an overview of various DR programs offered by regional transmission organizations or independent system operators (ISO) in the USA.

While making a theoretical assessment of DR potential in Europe, [102] considered flexible loads distributed geographically and their availability, based on the statistics of industrial production and electricity consumption, in addition to temperature-dependent and periodic load profiles. The analysis revealed a significant theoretical potential of DR in Europe.

As per The North American Electric Reliability Corporation’s recommendations, the FERC divided DR into two categories, namely, PBDRP and IBDRP [97]. Knowing that PBDRP may not be suitable for Kuwait’s electricity pricing system as Kuwait follows a single rate irrespective of the time of use, practices followed under PBDRP were studied and are presented in the subsequent section.

3.5.2.1. Price-based demand response program

In an ideal electricity system, the supply and demand of electricity always match, and any disturbance in the system will influence its equilibrium and electricity price [103]. PBDRP is a mechanism that offers time-dependent rates for using electricity. Users may have to pay a high price during peak load period and will have to pay a relatively low rate during nonpeak hours. The main aim of introducing such a program is to make customers use less electricity when its prices are high. According to FERC, PBDRP has beenmainly divided as time-of-use (TOU) rates, RTP, critical peak pricing (CPP), and peak time rebates (PTR). Peak demand occurs when a lot of customers use electricity at the same time.

In TOU rate system, the retail electricity price varies with time [104,105]. In this scheme, at peak time, users need to pay a higher rate than that of the lean time. As electricity needs to be produced and consumed simultaneously to match the grid stability, a lot of ESCOs encourage to use electricity at a lower rate during the nonpeak hours so that they need not shut down their generating facilities. TOU rates influence end users to shift their electricity requirements from high-cost (peak) to low-cost (nonpeak) hours. Specific loads like dishwashers and washing machines can be targeted for availing this facility. ESCOs use SMs to bill their customers accordingly. Some ESCOs are capable of monitoring the bills online as well. Major ESCOs have TOU rates based on the time of the day (day versus night), the day of the week (weekdays versus weekends), and season (winter versus summer) [106]. By using proper methodologies, the cost of electricity can be reduced for consumers who have enrolled for TOU-based DR programs [107,108]. An economic DR model developed by [109] incorporated the willingness of consumers to relocate their time of usage and offered optimal demand pricing for them.

RTP is generally applied for electricity consumers with a high demand, which happens with network peak load. These participating customers should have the ability to curtail their demand to get the advantage [110]. Strategies adopted for RTP are identical to TOU. The difference is that TOU is a monthly based (or even longer) contract, while RTP is an hour-ahead or day-ahead (DA) program. In addition to SMs, a continuous communication system needs to be established between the customer and the ESCOs.

The critical peak period is usually identified based on the historical data. ESCOs make contracts with customers for some pre-identified limited number of days or hours. Usually, CPP rates are much higher than TOU and RTP rates. Strategies used for implementing CPP are similar to TOU and RTP, which are the commonly used dynamic pricing types [111]. In the PTR scheme, a rebate is given to the participating customers for reducing their consumption below a pre decided baseline. The baseline is estimated based on the previous year’s electricity usage. Likewise, for CPP, the number of days and hours for a calendar year is pre decided. Strategies used for implementing PTR are similar to those of TOU, RTP, and CPP. As customer baseline (CBL) is an important parameter used to compensate consumers for their load curtailment, different methods are developed to calculate it accurately [112]. However, by artificially inflating the base load, strategic consumers can get more compensation than they actually deserve. By appropriately designing the contract, utility companies can overcome this threat [113].

In the process of identifying the frequent failures of DR, [114] commented that DR programs’ share in DSM is meager. The progress of the DR programs in the markets of Pennsylvania-New Jersey-Maryland Interconnection (PJM) and New York Independent System Operator (NYISO) was studied [95], and it was learned that emergency or reliability-based programs are getting a good participation. They urged the stakeholders to continue their efforts for increasing the DR participation, as it is deficient now.

A DR algorithm was developed for smart homes/ buildings, and efficient load control was achieved in response to the RTP data, which helped reduce the peak power demand [115]. The financial impact of using DR in the perspective of the retailer was examined by [116], and they argued that the electricity retailers who utilize DR can gain considerable financial benefits. [117] introduced a new differential pricing structure, named as user expected price, was introduced for residential consumers and proposed a new algorithm, which compares it with RTP to schedule the operation of household electrical appliances. By using an energy storage system (ESS), consumers store energy during the low-price periods and utilize it in the high-price periods. A load management strategy based on RTP was proposed by optimizing discussion between the consumer and the retailer [118]. According to the results, a reduction in the electricity bill, between 8% and 22%, was achieved on a typical summer day.

DR programs with and without DA program were conducted by [119], from the economic and reliability aspects. After analyzing the economic DR program in the PJM electricity market, [120] identified that the money flow from generators to non-price responsive loads contributes to the broader economic effect. Customer's behavior relation to various DR programs was modeled using a comprehensive DR model in day-ahead real-time pricing (DARTP) [121]. This was done through a Q-learning based approach optimization technique, and the results claim that composite demand function is suitable for all consuming sectors. A new RTP model was designed by [122] to cover RTP barriers for supporting the energy provider using the most suitable hourly DA prices. The primary aim of this model was to maximize the retailer's profit taking into account the elasticity in demand and user's benefit. In a recent study, [123] discussed strategies for retail electricity providers, to manage risk in a DA market.

A DARTP model, which can help distribution company and/or a retail energy provider suggest the best DA hourly prices while using SM, was proposed by [122]. Many utility companies offer both fixed and time-dependent pricing schemes together. A PBDRP for utility companies was developed to introduce the DR programs in such markets [124]. From the results, it is evident that the proposed dual-price system is helpful to both utility companies and customers.

A system dynamic method was developed by [125] to study the optimization of the real-time pricing system in the Chinese electricity market. They investigated different RTP mechanisms based on load and cost structures, and bidding, and analyzed the condition of consumer contentment and the total social surplus in various types of pricing. After conducting an analysis of various examples and comparing them under different RTP scenarios, [125] explored and designed the future dynamic RTP mechanism in China, predicted the dynamic RTP level, and provided a standard for RTP promotion in the future.

Three nonlinear economic models of price receptive loads for DR programs were developed with the perception of customer benefit function and price elasticity of demand [126]. They were used to determine the consistency with operational strategies and recommended for examining the effect of DR programs on demand curve. After mining various mathematical models for TOU pricing, [126] identified the nonlinear model with power structure as the most conventional one with respect to the initial load curve in case of price spikes. It was also noticed that both linear and nonlinear models behave similarly during small electricity values and small price deviations. A dynamic pricing strategy was tailored to reduce the electricity consumption of residential users by [127]. A fully distributed approach and hybrid approach were considered, and they claimed that the results were beneficial to reduce the electricity bills of the residential customers.

A report by Energy Market Authority listed out the main structures and regulatory framework of the DR program initiated by them [128] for the National Electricity Market of Singapore. An optimization model was proposed by [129], to schedule the household appliances optimally under TOU rates. The optimal solution obtained can be suggested to the consumer for cost minimization and to earn financial incentives. While conducting a critical review of DR programs, [130] presented an overview of the challenges and benefits of DR programs. They commented that challenges, such as lack of experience, realistic evaluation, etc., must be handled before their execution. Response to peak and off-peak differential prices on weekday was experimentally analyzed among the household participation group in New Zealand [131], but no effect on the TOU price changes was found. This result strengthens the argument on TOU pricing, as an ineffective DR instrument.

How effectively RES contribute to the operating reserve of a power system was estimated by developing an improved probabilistic approach [132]. Many factors, including the aging of the scheme, could lead to the reduction in the production of the RES.

Costs connected with the provision of energy, reserve procurement, expected interruptions, and environmental pollution were studied as part of social cost minimization by [133], and their impact on environmental and economic cost characteristics was reported. While reviewing the available DR business models, [134] analyzed different business models in EE and DR of various electricity markets and commented that more business models are available for DR than for EE, specifically in the system operation/retailer segment. Ancillary services are useful for ensuring the consistency and safety of power systems. In their study, [135] reviewed the advanced real-time electricity markets associated with the relevant ancillary services. The available opportunities in the ancillary service markets in six ISO regions in the USA were discussed by [136], and PJM and Electric Reliability Council of Texas (ERCOT) were identified as having the most suitable situation for DR partaking in the market.

The operational rules for power producers and suppliers in Japan were discussed, and an operating system, including a load dispatching control center and remote terminal units, [137] was described. An efficient pricing method was proposed to handle various problems related to smart pricing with the implementation of energy consumption controller, and different users' priorities and electricity usage trends [74] were analytically modeled. Further to that, a stochastic optimization model was formulated to operate an energy consumption scheduling device in a residential unit, which was equipped with an RES and a local battery bank [138].

A survey was conducted on different models of DR in the residential power sector to address the load shedding problem in India, which provide an optimal schedule for the schedulable and interruptible load (IL) [139]. A model for a load-serving entity (LSE) was developed to manage the DR by offering economic rewards to retail users, to increase its anticipated benefit and reduce the risk of market power experience [140].

With a focus on customer satisfaction, load characteristics were improved using an economic model based on CBF and PED [141], and it was found that this model is suitable to price responsive loads. [142] focused on price taking and real-time customers while developing a model for DA retailing operations for their consumers using pricing schemes such as fixed pricing, TOU, and

RTP, and explained how it is beneficial to the retailing. [143] developed a demand-side energy management model for a household having grid connectivity and capable of generating some energy from RES, and argued that the developed model based on a TOU pricing scheme efficiently schedules the household appliances and supports the end user by minimizing the daily electricity cost. Profit maximizing for CPP to help LSE was designed by [144] after conducting different analyses. They also studied the effects of change in various parameters on the CPP profit with the help of a price responsiveness model of customers. By referring to the results, authors argue that the optimal peak rate is approximately negatively proportional to the price responsiveness of clients.

From this section, it is reconfirmed that PBDRP is not a feasible option to be implemented in Kuwait in the current scenario as the prices are highly subsidized, and the government has no plan to lift the subsidy entirely in the coming days. The funneling method of literature review is diverted to focus on the alternate DR option, named IBDRP, which is discussed in the subsequent section.

3.5.2.2. Incentive-based demand response programs

IBDRP recompense end users for cutting down their electricity usage based on request or for giving ESCO permissions to regulate their electric equipment. Similar to PBDRP, FERC [96] divides IBDRP into the following different types: direct load control (DLC), IL, emergency DR, load as capacity resource, spinning/responsive reserves, non-spinning reserves, regulation service, and demand bidding and buyback.

By participating in the DLC program, commercial and residential consumers permit ESCOs to switch off their electrical equipment in a short notice. In this scheme, proper infrastructure is required to switch off the desired load remotely. Most of the ESCOs implement DLC by establishing a two-way communication (TWC) between the control unit and the controller, which is attached to the desired load [130]. Typical loads controlled by DLC are AC, water heaters (WH), pool pumps, etc. For residential sectors, this can be accomplished by installing a good energy management/ automation system [145]. For facilities that do not have TWC, time of the day controllers are also used to achieve this goal. By the proper implementation of DLC, peak to average ratio of the grid can also be smoothened [146].

Users or implementers must be capable of taking out IL from the network within seconds to maintain frequency stability in the grid. IL is an ancillary service, part of the instantaneous reserve, which is mainly used to take the load whenever the system frequency falls below 49.2 Hz [147]. By participating in the IL program, large energy users can earn regular income by helping to maintain grid stability. Similar to many other DR programs, IL also should have the capacity to control the load of the participating customer, whenever they want to shed the load to maintain grid stability.

Emergency DR programs are connected to pre-planned emergency events of program sponsors such as ISOs and ESCOs. In return for the willingness to participate, incentives are given to the consumers [96]. In their study, [148] identified data centers as one of the significant participants of emergency DR. According to them, by optimizing incentives, both owners managed, and tenant-managed data centers can be used for emergency DR.

Load as capacity resource are DSM resources that are obliged to perform predefined load curtailment whenever system contingencies occur. Participating customers are given incentives in return, for allowing to control their electrical load [97]. Similar to other DR programs, the minimum criterion required to carry out this program is the ability to control the load remotely, locally or through a proper communication channel.

Traditionally, spinning reserves (SR) are generating facilities, which are available to the electricity grid operator in a standby mode to maintain the stability of the system whenever a major disorder, such as the sudden shutdown of a large power plant or a major transmission line, occurs. DR spinning/responsive reserve is a technological replacement for the traditional one [149,150]. By the interconnection of small, controllable, residential loads with the help a technological framework, traditionally idling generating facility can easily be replaced. The necessary framework should have the facility to deliver a full response within the desired time.

In addition to the facilities used for other DR programs, spinning/responsive reserve needs a better technological framework to switch the load. The main difference between spinning and non-SR lies in the response time [151]. While replacing this with DR programs, the difference lies in the infrastructure required to respond to the requirement from grid operator. Similar to the other IBDRP, both types of SRs need to have a contract between the user and the ESCOs. As non-SR has more time to respond to the operator’s requests, a high-end infrastructure may not be required in this case.

In the regulation service scheme, demand resource increases or decreases load, responding to the active signals received from ESCO. Regulation services will be delivered continuously during the contractual period, which helps match the total electricity generation with the total demand in each second [152]. This facility requires interconnection with automatic generation control to match the production with the load.

Demand bidding and buyback is a low-risk program, which pays the user an incentive to reduce his load during the day-long events [153]. This is applied to both wholesale and retail markets. The participating users are enabled to submit their bids to ESCO for load reduction on a DA basis if they are able to reduce the load of minimum 10 kW for at least two hours. The infrastructure required for demand bidding and buyback is similar to that of other major DR programs. Many ESCOs have their own DR programs with different names. However, each of them will fall under any of the abovementioned types.

[99] examined a proposal to see the feasibility of introducing IBDRP in the New Zealand electricity market and recommended to ensure substantial investments in the areas such as communication, SMs, and latest devices, prior to the implementation of any sort of DR.

[154] examined the best suitable DR program for the industrial and commercial sector in Saudi Arabia and suggested IBDRP as the most

appropriate option. Time-varying retail pricing schemes, which are followed by Saudi Electricity Company were analyzed with the help of load patterns obtained from the industrial and commercial sectors [154]. The results pointed out the limitations of the existing scheme and the authors recommended to replace it with IBDRP.

A compensation scheme based on the nodal interrupted energy assessment rate, which focuses on nodal reliability and consumer readiness to pay for system stability, was developed by [155] to inspire the consumers, who wanted to use AC as a load in the DLC program. This newly deveoped scheme was used for bidding customers who have AC load and authors claimed that the new scheme improved the system reliability along with the reduction in the system operating cost.

Based on stochastic programming, a new method was designed for LSE to find out the most appropriate buying policy of ILs for a specific time period, which is helpful to reduce the risks in the market pointed by a multi-period risk measure [156]. To prevent change in expected profit/risks, it is recommended to have IL contracts in situations where supply or unexpected change in the demand occurs and accordingly the prices are sharply increased. The economic effect of flexibility in consumption was investigated by [157] targeting the distribution system operators under the current regulatory remuneration. This work was supported by a Swedish case study. The overall assessment indicates that decreasing peak consumption will lower the whole costs for the LSE and consumers. [158] developed a framework for IL contracts for electricity retailer and studied how these contracts support retailers limit their exposure to variations in the supply and demand of electricity.

[159] proposed an approach for verifying the time-based medium-term and short-term judgments for a trader, who buys electricity from the market, and suggested an optimal strategy. This was developed by determining the most appropriate interruption policy and price. How the different incentives, rewards, and penalties offered to consumers influence the load profile was

studied by simulating the behavior of consumers and their satisfaction level [160]. This economic model will be useful to different ISOs. As most of the IBDRPs are based on the contracts, participants are liable to certain penalties in case they do not reducing their load as agreed. This aspect was introduced to the study of common economic models for DR, and [161] further contributed by developing a model based on the PED by considering the effect of rewards and penalties along with benefits on customers. The outcomes claimed that customers' demand rest on on the PED, electricity price, reward, and the fine values calculated for the corresponding DR programs. Elasticity represents the consumer response to a tariff or incentive. Hence, it is essential to gather consumer elasticity data exclusively for IBDRP, for an efficient design of IBDRP [162,163].

[164] developed a co-optimized DA energy and SR market to reduce the anticipated net cost in all credible system conditions and claimed that this model could reduce the overall system operating costs in addition to the promised capacity reduction. Day-ahead DR program was introduced as one of the sources of SR for IBDRP [119] to decrease the total reserve cost and to improve reliability. With the help of two-stage stochastic program, [165] discussed the efficient risk management plans for the REPs to handle the uncertainties of the DA market and to control the monetary damages in the market, and established a financial IBDRP and the finest dispatch of the DG units and ESS. This work was done as a continuation of [166] to model a framework, which controls the perspective for market power and assists the LSE in financial risk management during the DA market. They also developed a model for LSE, to manage the DR by offering monetary benefits to retail customers, for increasing their anticipated profit and minimizing the risk of market power experience [167]. [164] proposed a full model of DR, where flexibility of demand was fully exploited by the bids based on the load, which can be shifted, as well as SR bids in the reserve market. Results claimed that the proposed DR model could again minimize on/off operation of generators and variations in system reliability, compared to normal demand shifting programs. [168] examined the different technologies used in the batteries to

find out the impact of vagueness in input parameters on life-cycle costs and reported that the differences in mean life-cycle costs across technologies are unimportant for most electricity storage applications.

In addition to managing physical properties efficiently and tackling the risks of market price and varying load, electricity traders are able to introduce IBDRP with the help of advances in smart grid technologies [140]. The advantages of upgrading electrical grids to smart grids were discussed in detail by [169,170]. An incentive-based electricity usage planning scheme for the upcoming smart grid having TWC system was proposed by [171]. From the simulation results, it can be confirmed that the developed scheme can lower the peak to average ratio of the whole electricity demand, the complete costs of electricity, and user's electricity prices. An integrated DR program with a smart energy hub was detailed by [172]. By referring to the simulation results, authors claimed that switching the energy sources could be beneficial to both consumers and utility companies. Smart grid networks have the capability of integrating multiple suppliers and consumers. To provide the maximum benefit to both utility companies and consumers, [173] developed a DR algorithm, in which the integration of multiple users and suppliers could be carried out. In another study, [174] proposed an aggregate game for the modeling and analysis of energy usage in a smart grid, with minimum interaction between consumers and utility companies. With the help of a framework developed by [175], retailers can benefit from their generation and storage resources, to reduce the peak power efficiently.

A method for integrating RES by deciding appropriate incentives, related to investments in distribution networks, was developed by [176]. The proposed method can be useful for regulators to exploit RES effectively. Another model was developed to suggest how retail electricity providers can sustain in a competitive retail market with assets such as distributed power generation units and ESS [165]. Even though replacing old coal-fired power generation units with RES is beneficial to the environment, economic barriers reduce the pace. For the active integration of RES, [177] developed an economic model by introducing IBDRP for small consumers.

One of the important issues related to residential consumers having SM but paying a fixed rate for their consumption was addressed by [178]. To utilize the availability of SMs, a coupon incentive-based DR program was recommended for small or medium sized commercial and industrial users, and extensive mobile communication possibilities and smart grid technologies have to be explored to make sure the participation of the customers in DR programs.

Different contracts and agreements that can be used by retailers to buy DR from aggregators and end users were proposed by [179] with the help of a newly developed DR scheme.

With the aim of developing load reducing actions for the electricity retailer, a multi-objective optimization model was prepared by [153]. With the help of a scenario-based participation factor, a stepwise IBDRP was developed, keeping an eye on the uncertainty of customers' behavior [180]. The results of the model would be useful to those retailers who are risk-neutral and focused on profit making.

The CDR model developed by [121] shows the hourly variations in the response of customers based on the anticipated benefit and the PED, hourly electricity cost, incentives offered and pre decided penalties in various DR programs. A mathematical model for flexible PED was designed to estimate the flexibility of each DR program, according to the electricity price, before and after its implementation [141]. Also, by using strategy success index, the preferences of each stakeholder were determined. A simulated DR program was developed to reduce the patterns of electricity consumption by adjusting loads without disturbing consumers [181]. The results show that the suggested method helps different inmates staying in a house manage and plan their requirements easily based on their importance and preferences.

An hourly pricing mechanism was developed focused on load characteristics to increase the effectiveness of DR, combined into the DA scheduling framework of smart distributing companies [182]. Results confirm that the nodal hourly plan proposed by them make the highest profit for the SDC in addition to providing considerable rewards for consumers to change their demand curve and decrease their electricity bill. By using an hourly acceptance function, customers' reaction to the suggested hourly prices was modeled [183]. The prices approved by regulators were used for this purpose. In this scheme, the retailers urged their dynamic customers to join the day-ahead DR program and lower their electricity usage to receive the rewards. According to the results, with the help of consumers, the total operational costs of the microgrid were reduced. Moreover, this contributed to lessening the usage of diesel generator too.

In one of the review studies on IBDR methods, [184] arranged different tools under five broad categories such as game theoretic, coupon based, statistical and optimization methods, dynamic incentives, and control methods. A number of game theory-based studies were conducted in different areas such as bid-based market [185] and TOU tariff-based market [186]. Game theory is also used for optimizing incentives with the help of forecasting user's optimal demand [187], formulating a dual incentive scheme [188], and developing a pricing mechanism for balancing generation and demand [189], etc. Many studies recommend the efficient use of coupons as an alternative to price-based mechanism [178,190,191]. Hardly any study in the field of dynamic incentives focuses on approaches, for instance, introducing energy sharing and control for different houses [192]; hierarchical scoring mechanism among customers, distributors, and generators [193]; dual-tariff scheme to ensure maximum profit for the utility companies [194], etc. Other similar studies concentrated on cost and benefit analysis [195], creation of a uniform consumption profile [196], generation of attractive packages for consumers [197], etc. Statistical models were developed for topics such as predicting the peak power reduction capabilities of different consumers [198] and studying the effect of incentives on residential consumers' usage pattern [199]. In another optimization-based study, [200] developed and validated a model to utilize both distributed energy resources and DR effectively. By developing a formula, [201] examined the profitability of the consumers participating in the IBDRP, specifically DLC in a different significant analysis. Studies on the role of proper control strategies and their impact on the effective implementation of IBDRP were conducted by many scholars. Some studies focused on areas such as the incorporation of the centralized and entirely dispatched control strategies for demand bidding program [202], and the development of control strategies for the charging of electric cars, by protecting transformers [203].

3.6. Summary of literature survey

The literature survey carried out in this study revealed some important segments, where Kuwait has superior strength. The major ones include the availability of funds to implement innovative ideas in terms of energy conservation and EE; government's commitment to keeping the environment clean; abundant availability of RE, in particular, solar and wind; government-owned monopolistic market, etc.

As a solution to meet the growing electricity demand in Kuwait, the literature suggests to consider DSM instead SSM, which is currently followed. Accordingly, general information on DSM and its implementation status in different countries was gathered, which includes various statistical and mathematical models developed in this field. The results indicate that not all projects are successful, and one successful program in one region may not be successful in other regions. This emphasized the importance of selecting the most suitable programs based on different influencing parameters. As an established subdivision of DSM, EE measures are very popular in many countries compared to their counterpart, DR. Kuwait has good experience in the field of EE, and from the literature, it is evident that Kuwait has experience in implementing most of the methodologies adopted in other parts of the world. This forced researcher to concentrate on the less tackled division of DSM, i.e., DR.

The subsidized price of electricity is identified as one of the crucial obstacles that restrict the effective implementation of EC programs. However, due to political and social reasons, any change in this structure is not expected in the present scenario. As the price of electricity is fixed, irrespective of time of the time of the day and seasons in Kuwait, introducing PBDRP is not appropriate in the current scenario. However, a rethinking needs to be done to integrate PBDRP with IBDRP, whenever a change in electricity price is introduced. Even though the government initiated many programs to increase the awareness among residents to conserve electricity, the missing driving force for conserving energy is identified as the lack of motivation. Thus, implementing IBDRP is a good solution, irrespective of the identified weaknesses.

From the referred literature, it is evident that all of the buildings are equipped with AC, and substantial potential for electricity savings is available in all of the sectors, which give, many opportunities for IBDRP. Any reduction in the electricity consumption will have a direct impact on the decrease in PEC and an indirect effect on the reduction of PCE. This gives an opportunity to trim down Kuwait’s rank among other countries regarding PEC and PCE. Additionally, any savings made in the oil reserve offers opportunities for revenue generation or energy security.

As an outcome of the literature survey, several research gaps were identified, where research can be carried out. Some of the major gaps are listed subsequently:

- A country-specific study on the association between electricity consumption and economic growth, either for Kuwait or for countries with similar characteristics.
- A detailed study to find out the impact of oil price fluctuations on the DSM measures.
- An explicit study to identify major barriers to DSM implementation in Kuwait.
- A study on the link between responsible customer and supplier engagement in DR programs in the Kuwaiti context.
- A study on the cost-effectiveness of different DSM measures.

From the above-identified possible research areas, two major gaps were selected for this study, which are subsequently elaborated. The selection was carried out based on the nature and the current scenario of KES and the non-availability of the framework to introduce any DSM-based programs in Kuwait.

3.7. Selected research gaps

Based on the literature survey, two main gaps were formulated, which are mentioned subsequently:

- No study could be found that addressed the IBDR feasibilities in a subsidized electricity market such as Kuwait
- The acceptance of various IBDR programs by the consumers in Kuwait's residential sector (KRS) has not been addressed in any of the studies.

3.8. Summary

To find out a suitable solution for the business problem, a detailed literature survey was carried out using the funnel method. Initially, three themes, such as "the impact of EC on economy and environment", "EC policies and planning", and "electricity subsidy", were selected, which emerged directly from the business problem. The funneling down approach of literature review stressed on the importance of DSM and its major subcategory DR. While studying the different DR possibilities, introducing IBDR programs in Kuwait's market, as a solution to the business problem, was found to be appropriate but not addressed in any of the earlier studies. Accordingly, the final research gaps were identified as "developing an implementation framework for introducing different IBDR programs in the subsidized electricity distribution market of Kuwait", and "checking the acceptance of different IBDR programs by the consumers in the residential sector of Kuwait".

Before framing the research methodology, the theoretical premise for the research gaps and its relevance to the current study was studied, which is explained in the next chapter.

4. THEORETICAL PREMISE

4.1. Introduction

Development of theory depends on research and research counts on theory [204]. Theories play a significant role in research to understand, explain, and predict various concepts. During many occasions, theories are challenged and extended to increase the knowledge base within their boundary assumptions. Theoretical premise introduces and explains the theory that further clarifies the research problem under the study area [205]. All research works need a theoretical background for analysis and interpretation. At the same time, theories need to be continuously reviewed by research studies. The outcome of the research contributes not only to the literature part but also to the theory on which the research is carried out.

As per the identified research gaps mentioned in the previous chapter, a new literature survey was carried out to find out the most suitable theoretical premise of the research. In this study, since the feasibility of introducing incentives in a subsidized electricity market is being focused on, and according to the preliminary assessment, the research area is related to different theories of motivation.

For the accomplishment of any result, appropriate actions are required. Many a time different obstacles thwart the smooth transition, and it may influence the behavior of people. To an extent, motivation is helpful to overcome these types of hindrances. A group of variables that determine the behavior is called as motivation, which is different from learning. The new association is formed with the help of learning variables, which is potential for specific behavior. By introducing appropriate motivation, the abovementioned potential can be converted into a behavioral manifestation. Motivation is divided into two, namely, intrinsic and extrinsic. The intrinsic motivation reflects the natural human tendency to learn and practice for attaining inherent satisfaction, while the extrinsic one is the result of some external influences [206].

Over the years, many theorists worked on the concept of motivation and developed several theories. Incentive theory of motivation (ITM) is one of the widely followed theories among them. As this proposed study aimed to explore the impact of incentivizing people to achieve load reduction, ITM is found to be an appropriate base theory.

4.2. Incentive theory of motivation

Motivational studies were initiated by William McDougall in 1923, which were further expanded by many researchers such as Freud, Murray, Clark Hull, Kenneth Spence, Crespi, Kurt Lewin, etc., who made a substantial contribution to strengthen various aspects of human motivation [207].

The ITM is focused on motivating people through rewards, which will eventually influence the behavior of individuals [208,209]. Incentive based motivation is a drawing force, and the incentive is said to “pull” peoples toward a target. The drawing force starts from the remuneration object in the target and is focused on the anticipation of the goal object in specific areas [207,210].

The influence of incentives in motivation was introduced by Mark Hull in 1943. According to Hull, the nature and magnitude of the incentives will influence the behavior directly. The relationships of behavior with the increase and decrease of incentives were also discussed by Crespi in 1942. Furthermore, in 1952, Hull established incentives as a determinant of performance. He formulated motivation as a product of drive, habit, and incentives. This concept was supported by Kenneth Spence in 1956 explaining how such rewards will influence the internal stimulus stage [211].

By collecting various information from different sources, a construct of ITM was prepared and is given in Fig. 4.1. From the figure, it can be seen that for any performance accomplishment, actions are required, which may face a lot of obstacles. These obstacles may negatively influence the behavior of the people, which can be regained by proper motivation. Undoubtedly, positive motivation is useful to reduce the obstacles for performance accomplishment.

People can be motivated intrinsically or extrinsically. Intrinsic motivation is the result of enriched awareness or self-esteem. Other parameters, such as enjoyment, commitment, reputation, self-development, etc., will also influence people intrinsically.

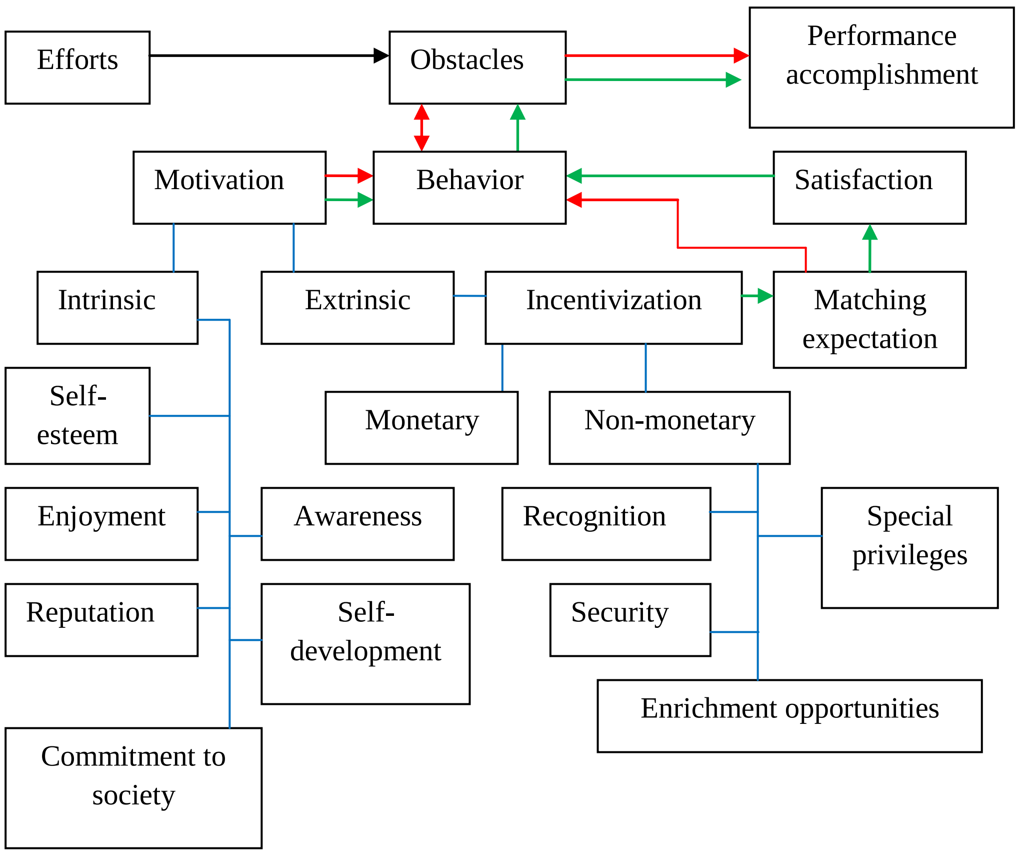

Fig. 4.1. Incentive theory of motivation

Extrinsic motivation is achieved through the incentivization of people. The two methods coming under this are monetary incentive (MI) and nonmonetary incentive (NMI). MIs deal with the financial gain, while NMIs are provided in the form of special privileges, recognition, security, and enrichment opportunities. As this research is focused on ITM, an attempt was made to understand various studies conducted on ITM, which is summarised as below.

4.3. Literature review on incentive theory of motivation

A detailed literature survey was conducted to explore the studies carried out in relation to the ITM. How citizens can be attracted to involve in casestudies, by providing extrinsic, intrinsic, and internalized-extrinsic incentives, was explained by [208]. In the network education platform, the four stages of teaching processes such as stimulate, guide, maintain, and evaluate, are well explained with the help of incentive theory by [212]. [213] developed a theoretical model to match with employees' contract stage and selection stage in the job market. The effect of monitoring people's activities even if it is connected to the incentives in future is well explained by [214] with the aid of game theory-based model. [215] described a new behavioral agency theory for theorizing focusing on behavioral assumptions. The authors argue that the developed theory gives a better outlook on executive compensation, the theory of agent behavior, and the stand for making suggestions. [216] carried out a study on the impact of incentives in the family and non-family business and commented that family firms offering incentive compensation plans would have lower labor productivity than nonfamily firms. [217] explained the role of contract theory in designing incentives in a wireless network market and suggested the use of new techniques from contract theory to address incentive theory.

4.4. Relationship with the current research

The focused research gaps in this study emphasize the importance of conducting research for reducing in electricity consumption with the help of consumer's active participation. In addition to the awareness, to ensure consumer participation, incentives can be offered. The backbone of the IBDRP is motivating consumers through incentivizing them to get the required power reduction.

It is evident that this study has a direct relationship to ITM. The purpose of increasing awareness is to increase the intrinsic motivation of consumers, while the incentivization is linked to the extrinsic motivation. By incorporating the learning from the ITM, this study was designed efficiently by developing an appropriate methodology to address the identified research gaps.

4.5. Gap in the theoretical premise

Though many studies establish the significance and role of incentivization as a tool for motivating people in various market structures, such as workforce, business, education, communication, etc., no comprehensive study could be found, which addressed its role in a subsidized monopoly market.

In this study, an attempt was made to understand the role of incentives in the subsidized electricity markets by finding answers to questions such as how to motivate consumers to enroll in the IBDRP activities, and how to ensure and maintain the participation of consumers in the IBDR programs. To match with the identified research and theoretical gaps, the following research problem is formulated.

4.6. Research problem

"What are the ways to motivate consumers through incentivization in a highly subsidized monopoly market for reducing their electricity consumption?"

4.7. Summary

All research works need a theoretical background for analysis and interpretation. At the same time, theories need to be continuously reviewed by research studies. As the present study deals with incentivizing consumers for reducing their electricity consumption, motivation and its associated theories can be linked to this study. Motivation is nothing but an urge in a person to perform the goal-oriented behavior, which can be categorized into intrinsic and extrinsic motivation. Intrinsic motivation refers to doing some action that is interesting and gives pleasure to perform it, while extrinsic motivation refers to external influences. Among the different theories of motivation, ITM is getting widely accepted among researchers in the recent years. The learnings from ITM is used in formulating different applications such as workforce, business, education, communication, etc. However, no comprehensive study is found that utilizes ITM in subsidized markets. Through this study, the identified research gaps will be filled by defining the role of ITM in a subsidized electricity market.

Each research problem will be different and needs to be solved according to the nature of it. Research methodology is an organized way of resolving a research problem. The next chapter explains the details of the research methodology used in this study.

5. RESEARCH METHODOLOGY

5.1. Introduction

Research methodology is systematically finding a solution for a research problem supported by a proper logic [218]. Depending on the nature of problem, the research methodology also changes. The research methodologies are broadly divided into quantitative, qualitative, and mixed methodologies, and based on the type of study, the most appropriate methodology needs to be selected [219].

Quantitative methodology is based on the rigorous analysis of quantifiable data collected during the study; qualitative methodology is related to the subjective assessment of different attributes; and the mixed methodology is a combination of both. The selection of the methodology was carried out during the research design phase of this study as detailed subsequently.

5.2. Research design

The master plan stating the techniques and process for gathering and analyzing the data required in a research study is called as research design. The core of the research process is the formulation of research objectives, which are used to design the research appropriately [220].

5.2.1. Research objectives

Research objectives are developed to provide an accurate description of the steps to be taken to solve the research problem. To address the research problem mentioned in the previous chapter, the following research objectives were prepared:

- To develop an implementation framework to introduce IBDR program in KES.
- To study the acceptance of the different IBDR programs by the consumers of KRS.

To match with the research objectives, a sequential research methodology, which is a combination of qualitative and quantitative methodologies, has been used for the study. Key factors related to this research study are given in Table 5.1, and the entire research plan is given in Fig. 5.1, where the interconnection of both methodologies is presented pictorially.

The research methodology adopted for the first objective comprised two stages: document analysis and experts interview. With the help of document analysis, various information available in the literature were gathered and arranged systematically. The learning from the document analysis was used to formulate questions for experts' interviews, and based on the combined results of both document analysis and experts' interviews, an implementation framework for introducing various IBDR programs suitable for Kuwait was prepared. To check the acceptance of the IBDR programs by the consumers in the residential sector of Kuwait, three IBDR programs were also suggested.

The outcome of the first objective was used for framing the questionnaire for the second objective. Here, the information were collected from the consumers in the residential sector with the help of a survey questionnaire and analyzed [218]. The analyzed results were used to formulate the outcomes of the study. The research methodologies for both objectives are detailed in the following sections.

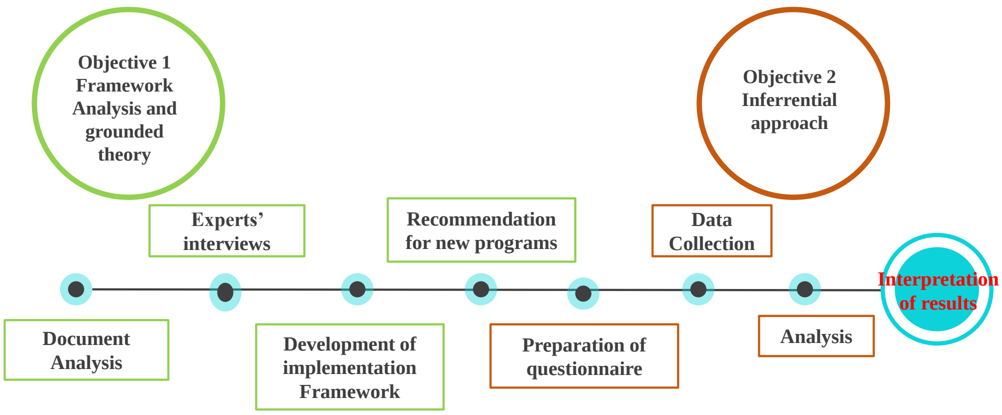

Fig. 5.1. Research plan

Table 5.1. Key factors of the research work

Factors	Description
Business Problem	Nonoptimal consumption of electricity due to subsidized pricing is leading to opportunity loss of revenue.
Research Gaps	1. No study could be found that addressed the IBDR feasibilities in a subsidized electricity market such as Kuwait. 2. The acceptance of various IBDR strategies by the consumers in KRS has not been addressed in any of the studies.
Theoretical Gap	Though many studies established the significance and role of incentivization as a tool for motivating people in different market structures, no comprehensive study could be found, which addressed its role in a subsidized monopoly market.
Research Problem	What are the ways to motivate consumers through incentivization in a highly subsidized monopoly market for reducing their electricity consumption?
Research Question	1. How to implement an IBDR program in KES? 2. How much is the acceptance of different IBDR programs by the consumers in the KES?
Research Objectives	1. To develop an implementation framework to introduce IBDR program in KES. 2. To study the acceptance of the different IBDR programs by the consumers of KRS.
Research Methodology	1. Qualitative methodology (combination of framework analysis and grounded Theory) 2. Quantitative methodology (Chi-Square test, Mann-Whitney test, McNemar Chi-Square test, and inferential statistics)

5.3. Objective 1: To develop an implementation framework to introduce incentive-based demand response programs in Kuwait's electricity sector

Research questions that need clarification or explanation of social phenomena and their situations are addressed by qualitative data analysis methods [221]. Unlike quantitative methods, here results are not formulated based on any mathematical equation but interpreted based on the interrelationship of the analyzed data. This methodology is adopted more in areas where an initial understanding of an issue or problem needs to be gathered, exploring one topic in-depth, which is sourced from different perspectives; look for a range of ideas and feelings about a subject, to provide a base for conducting quantitative data analysis, etc.

Since the first objective of this study was to construct an implementation framework for a new market, where it was not available, the qualitative research methodology was found to be more appropriate as it is an excellent tool to deal with 'how' type of questions [222]. It is evident from the past studies conducted using qualitative data analysis that there is no single recognized way of conducting qualitative research. Many factors, such as the type of the social world, nature of the knowledge base, purpose, participants, etc., influence the final mixing of qualitative research methodology [221]. As these types of studies may be influenced by the researcher's bias, a methodology, which has a structured process with well-defined steps, should be identified. Framework analysis is such an approach, which helps the researcher see how the different data are interconnected under different themes [223]. Even though the primary methodology followed for this objective was based on framework analysis, grounded theory-based coding was carried out for data analysis, which helped interpret the results more efficiently [224].

5.3.1. Sequential methodology based on framework analysis and grounded theory

There are different methodologies used for qualitative data analysis, which follow various approaches. Framework analysis is a widely used qualitative methodology, which is used to formulate meaningful results from the available literature.

The framework approach for qualitative data analysis incorporates five interrelated steps to explore the data and develop justifications or associations. In this methodology, the researcher examines the data, drafts a thematic framework of critical issues and concepts, indexes them, charts the data by bringing themes and subthemes together, and interprets the results by establishing connections and explanations [223].

With the development of the computer-assisted data analysis tools, a lot of researchers conducted the entire framework analysis with the help of software [225]. However, in this study, a combination of the traditional and software-assisted methodology was followed. Due to the size of the data, a software supported grounded theory-based qualitative data analysis methodology was used for the coding in this study. Grounded theory is used for formulating a story line through the identification of different themes and interconnections between them [219,221]. These story lines will be capable of contributing to the emerging theories in the social science. The backbone of grounded theory is its qualitative coding, i.e., the way of defining the data systematically for future analysis. With the help of coding, a lengthy sentence or a paragraph can be linked to one or two meaningful words or phrases. These primary codes are processed by sorting, integrating, and synthesizing to organize a large amount of data by focused/selective coding, which can be helpful in formulating the story line [226].

In this study, grounded theory-based coding was utilized for the analysis of qualitative data collected through different documents as part of the first phase of the first objective and the transcript information of expert interviews pertained to the second phase. Famous qualitative analysis software ATLAS.ti was used for the coding in both cases.

5.3.2. Steps of research methodology

The methodology adopted to meet the research question of Objective 1 was divided into two phases. In the first step, a detailed document analysis was carried out and based on its outcome, semi-structured interviews of experts were conducted in Phase II (Fig. 5.2). Combined results of both of these stages were used for formulating suitable implementation framework for introducing IBDR programs in KRS. The findings related to the consumer behavior were used to strengthen the theoretical premise.

The results were used to prepare three different IBDR programs suitable for Kuwait, to check their acceptability among consumers. The details of all steps in the research methodology are provided subsequently.

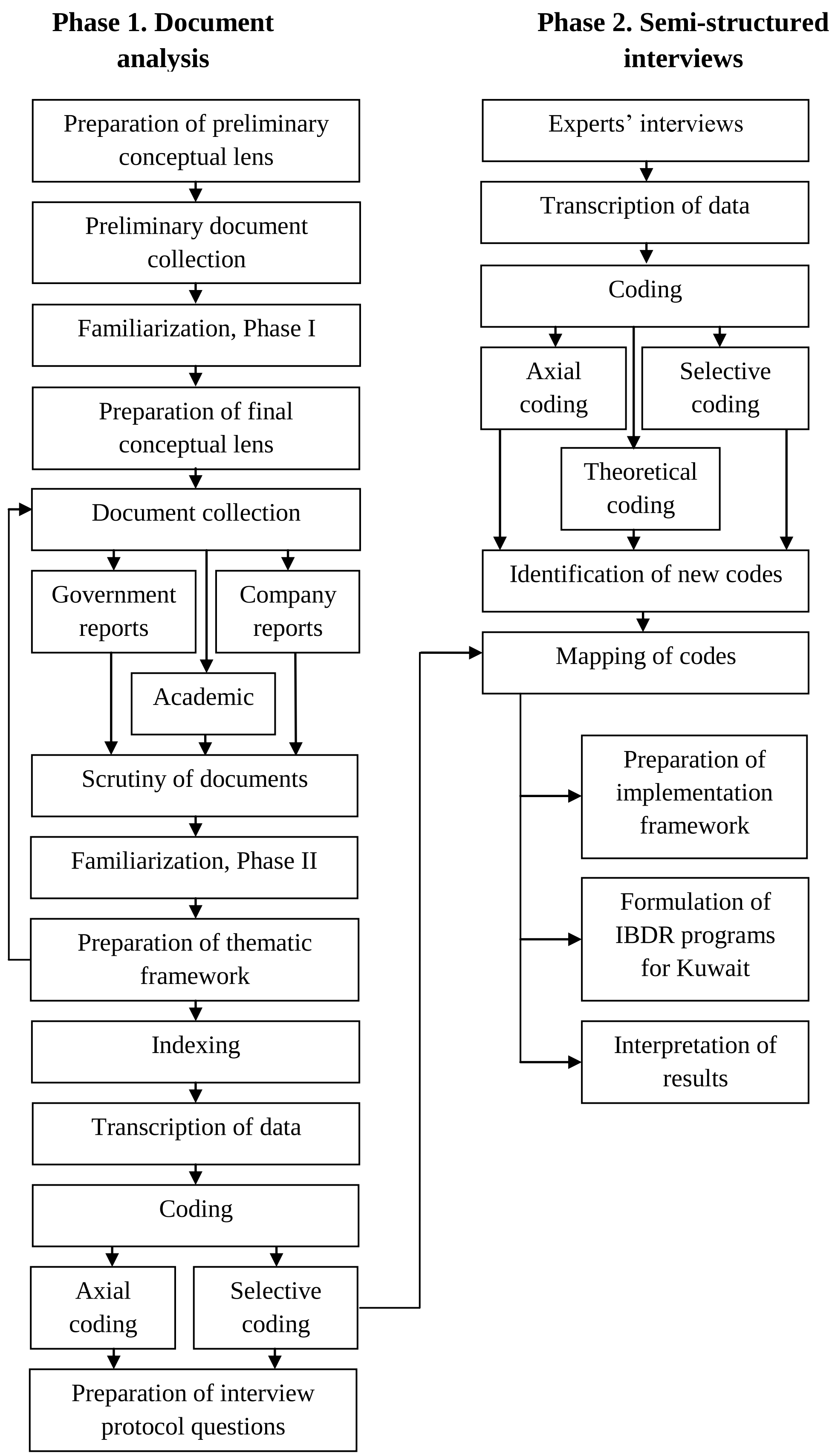

Fig. 5.2. Steps of research methodology for objective 1

5.3.2.1. Phase I: Document analysis

The first part of document analysis was carried out based on a well-practiced qualitative data analysis methodology, named framework analysis. Framework analysis follows a systematic analytical process in which the most important information is gathered from different documents, which are interlinked based on their meaning and importance. It has five steps namely, familiarization, identifying thematic framework, indexing, charting, and, mapping and interpretation [223]. In this study, the first three stages of framework analysis were used for gathering information from a large number of documents into a systematic indexed format. To handle the huge data in an easier manner, a software supported grounded theory-based coding was used.

Reading is adopted as a channel for knowledge gathering since ages, and systematic reviews helped to focus on specific areas [227]. Software-based document analysis is getting great acceptance among researchers who are doing qualitative data analysis, in which along with the documents in electronic format, printed materials are also analyzed after converting them into electronic format [228].

To start the process of data collection and analysis, a preliminary conceptual lens was created by considering the analytical, perspective, and methodological purposes of the study [36]. The conceptual lens is helpful to arrange the thinking process in a more organized way focusing on the problem in depth, to get different solutions. Some of the questions include, “What are the IBDR programs suitable for Kuwait”, “What are the barriers to implement various schemes”, “What is the required cost”, etc.

To find out the answers to the questions raised in the conceptual lens, a preliminary literature search was performed in different channels of information with keywords such as incentive, IBDRP, DR, DSM, retail market, consumer satisfaction, etc. In this stage, about 115 documents were selected, which included government reports, company reports, and research articles including theses, and, journal and conference papers.

After reviewing the collected literature, the first stage of familiarization report was prepared, in which all of the questions were kept as columns, and referred documents were marked in the rows. Page number, paragraph number, and line number were noted against different questions. This report helped understand the depth of the subject and enabled the analyst to view from different angles to visualize the subject better. Accordingly, the preliminary conceptual lens was modified with a lot of new questions to formulate a final conceptual lens. The final conceptual lens for document analysis is given in Fig. 5.3, and the related questions are presented in Appendix A1.

Based on the questions raised by the final conceptual lens, new keywords were identified and the second phase of document collection was initiated for which a reasonable amount of time was taken as it required a lot of attention and rereading. A well-known multistage sampling technique, named snowball sampling, was adopted in this study to reach the size of sample needed [36].

A detailed search was conducted for the identified key words in the top research databases such as ScienceDirect, Scopus, Web of Science, JSTOR, and Google Scholar. Reports of different commercial companies were also gathered by conducting multiple Google searches. The related text was copied along with the page number, paragraph number, and line number. All these data were entered into a separate Excel sheet as part of the preparation of familiarization report II. The information gathered for each question was allocated in separate sheets. As per the snowball method of sampling, new documents were selected from the reference lists of the referred literature, while reports of peers were collected for company reports. This process continued until no more new documents could be identified. A reasonable attempt was made to avoid the duplication of documents and exclusion of no relevant information, which did not directly address the research questions. Prior to the final selection, all documents were filtered based on the quality and relevance of the research questions, and accordingly, from the 517 collected documents, only 235 documents were selected. This number, inclusive of documents was selected for gaining more clarity to different themes identified as part of the thematic framework. Illustration of familiarization report is presented in Appendix A2.

The preparation of thematic framework is one of the crucial stages of framework analysis. During the process of familiarization, the researcher acquires knowledge about the richness, depth, and diversity of the data, after which the researcher begins the process of abstraction and conceptualization. After reviewing the collected documents, with the help of different concepts noted down during the familiarization period, the researcher identifies the key themes to match with the questions raised in the research objectives [229]. Accordingly, in this study, all of the collected information was arranged under various themes for better understanding and further analysis. Some of the collected documents that discussed various aspects of IBDR programs shed light on the benefits of these programs. Such information was gathered and arranged under the first theme named “benefits”. To organize various features of the available IBDR programs practiced worldwide, a new theme was introduced, namely, “features of the programs”. Likewise, it was observed that the various text collected from a range of documents could be linked to three subthemes, namely, “challenges”, “requirements”, and “activities”. Later, based on the stage of execution of IBDR programs, all these subthemes were repeatedly arranged under three main themes: “pre-implementation”, “implementation”, and “post-implementation”. The developed thematic framework is given in Fig. 5.4.

From the figure, it is clear that the entire information collected as part of document analysis was arranged under 35 categories. During the stage of indexing, all of the relevant information related to these categories was arranged in a tree-like format, which is similar to the content page of a book. An illustration of indexing is presented in Appendix A3.

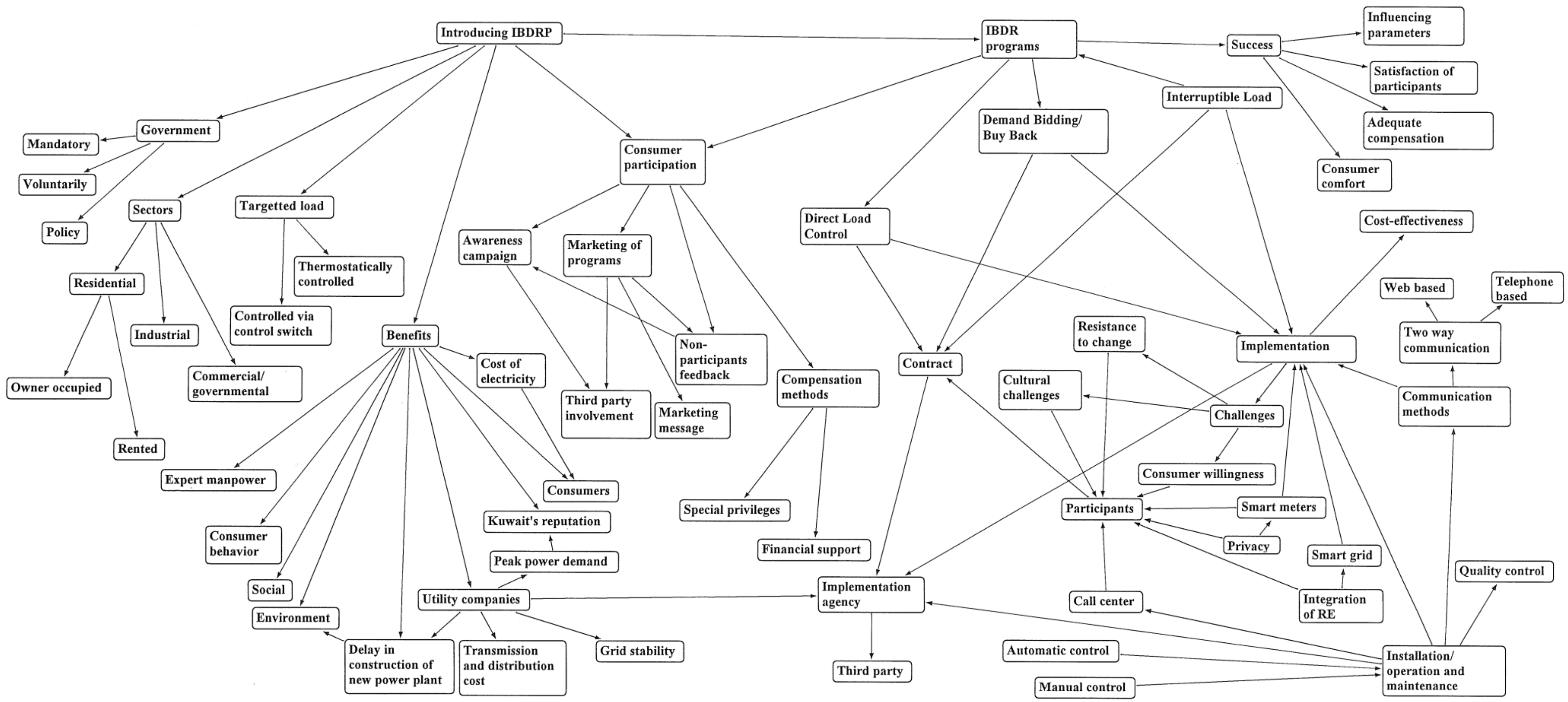

Fig. 5.3. Final conceptual lens for document analysis

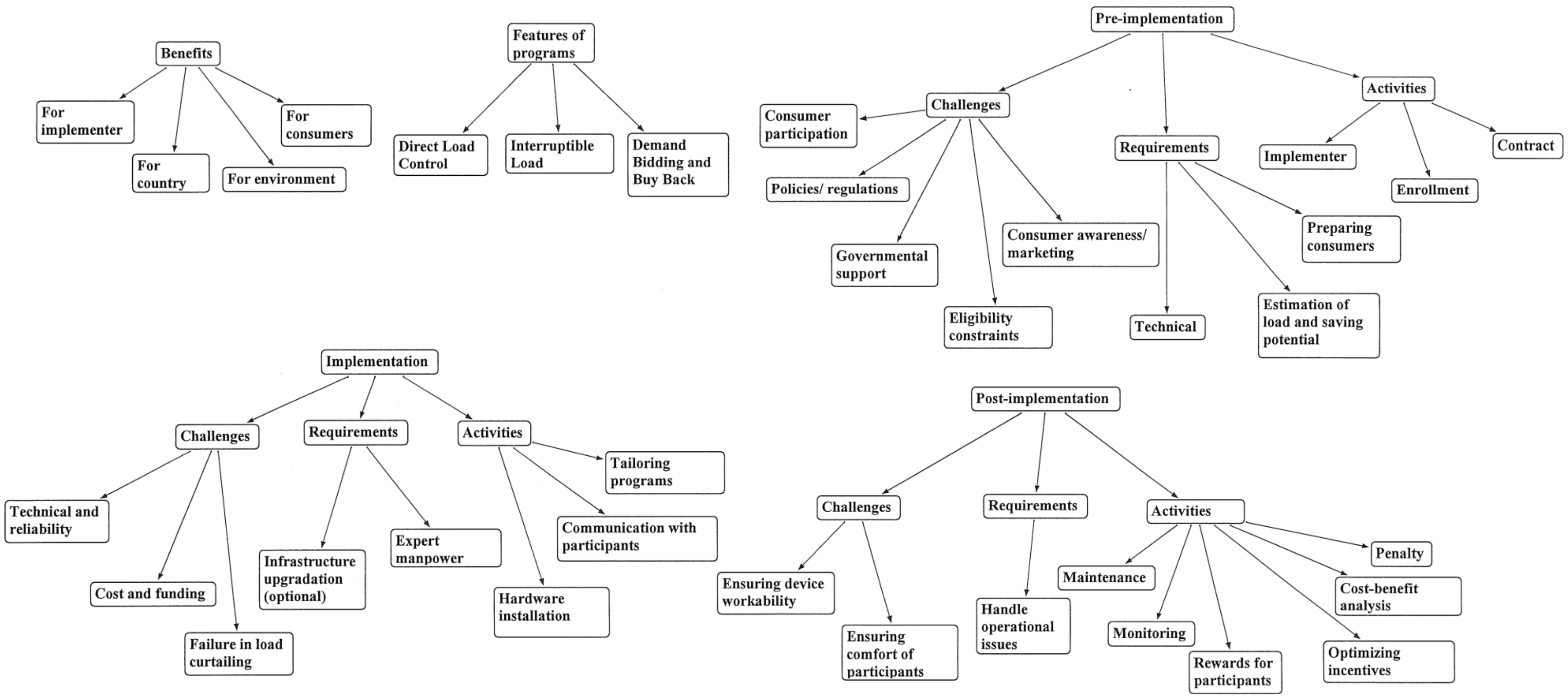

Fig. 5.4. Thematic framework

By indexing, all of the related texts collected from different sources were combined and brought under the most appropriate questions and sub-questions. As an example, under the first theme “benefits”, there are four categories, namely, “for implementer”, “for country”, “for environment”, and “for consumers”. All of these categories were converted into separate questions such as “What are the benefits for implementer?”, “What are the benefits for the country?”, “What are the environmental benefits expected?”, “How the IBDRP will benefit the consumers?”. By following the same pattern, a total of 35 questions were formed as part of indexing.

After formulating these questions, the answers related to all of these questions were put together to create 35 separate sheets in an Excel file. To reduce the size and repeatability of the collected data, inferences of the collected texts under different categories were prepared as transcriptions. Extreme care was taken to avoid researcher’s bias while preparing these documents. Illustration of a transcript is presented in Appendix A4.

Coding is used for arranging and labeling data, which are found to be attractive to the reader. In a document, all ideas, themes, and concepts, which are relevant and related to the study, can be considered as a code. As the codes are linked to the entire documents, researchers can analyze and make assumptions based on them. ATLAS.ti, a widely used software for qualitative data analysis, was used for the coding purpose [230]. With the help of ATLAS.ti software, grounded theory-based coding of all the 35 documents was carried out. The flowchart of coding process is presented in Fig. 5.5.

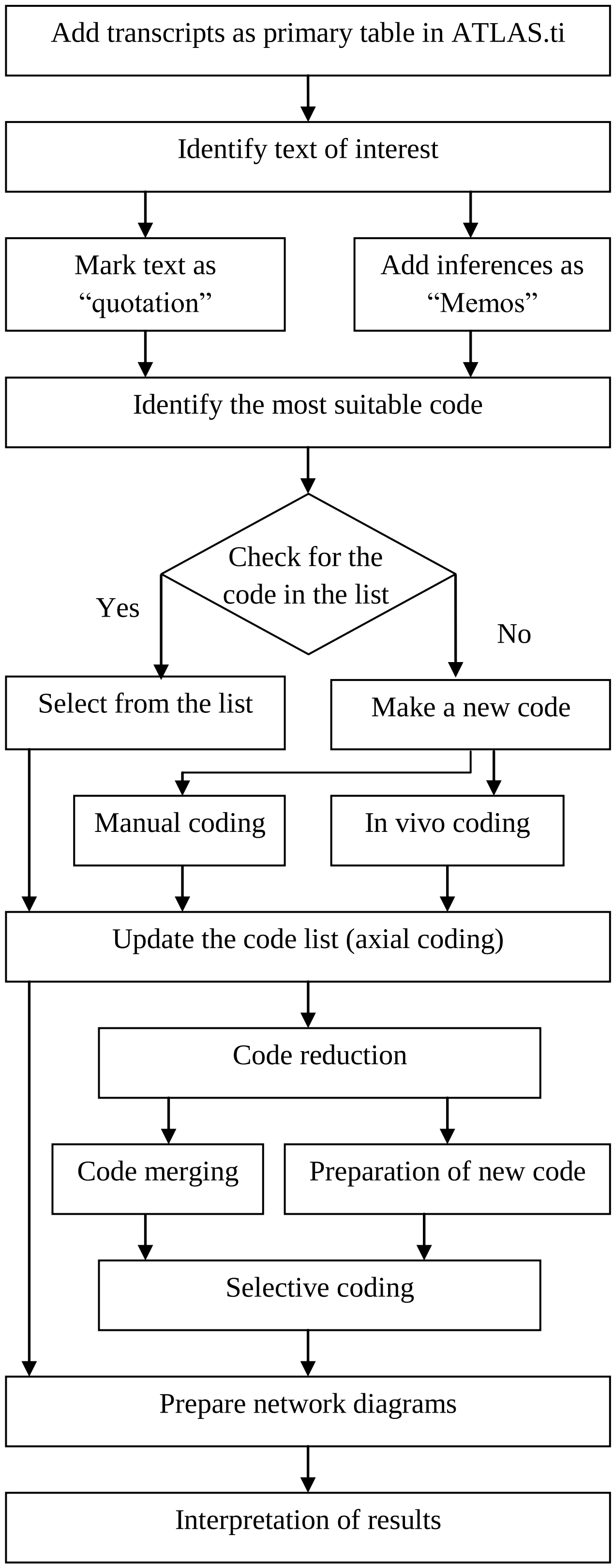

Fig. 5.5. The process of coding in ATLAS.ti

After adding the documents to the primary document table, the researcher had to read all documents in detail to find the text of interest. As the first step of coding, quotations and memos were prepared from the interesting parts of the texts. Quotations are data segments with specific start and end points, while memos are prepared by analysts based on their understanding after reading a particular part of the text available in the document [230]. Based on the contents and importance of the quotations and memos, the most appropriate codes were formulated. The coding process was carried out in three ways: manual coding, where codes were added manually; selecting from the code list, where codes were chosen from the codes library; and in vivo coding, where some words of the texts were added as codes. Irrespective of the coding process, all new codes were added to the codes library by the software. This process continued until no more new codes could be identified, and the researcher experienced code saturation. This method is similar to the snowball sampling method in the literature context [36].

A total of 328 codes were generated, which represented the different nodes of the complete framework for implementing IBDRP in the retail electricity market. An illustration of the coding process is presented in Appendix A5, and the complete code list in alphabetical order is presented in Appendix A6.

Axial coding is used to map different codes to form a network diagram with proper flow and meaning. With the help of diagrams based on axial coding, anybody can visualize the concept quickly. Similar codes may be repeated in different parts of the branch.

To reduce the number of identified codes to a sizable amount, selective coding was performed [224]. In this stage, the analyst is free to reduce the generated codes to a manageable quantity for easy understanding and representation. Even though a lot of statistical techniques are available to perform this task, in this study, the researcher managed to reduce the codes by repeatedly reading the texts associated with each code [36]. Code reduction was a challenging task as the codes had to be reduced without losing their importance. Based on the relations of different codes, a proper combination of codes was made, and they were merged together to reduce the number of codes. While merging, suitable precautions were taken to maintain the importance and relevance of codes, as the outcome of this step is the summary of data analysis. To ensure this, code reduction was performed in two ways. In the first method, similar codes were merged into one of the most suitable/related codes available. In the second method, a new code was formulated, which was suitable to represent a bunch of codes, without losing their importance and meaning. Axial and selective coding is detailed in the results and discussions section.

Even though the results are capable of addressing different aspects related to the implementation of IBDRP in the retail electricity market, Kuwait specific information was missing in the referred literature. This was mainly due to the lack of literature on IBDR related studies conducted in Kuwait.

To fill the above gap, country-specific semi-structured interviews of experts were conducted. This was used not only helped to gather some vital information related to Kuwait's market but also to triangulate the results obtained from the document analysis [231]. The interpretation of results obtained from both axial and selective coding was used for preparing the most suitable protocol questions for conducting the semi-structured interviews. The methodology for gathering country-specific information from experts through semi-structured interviews is given in the next section.

5.3.2.2. Phase II: Semi-structured interviews

Semi-structured interviews provide the opportunity to explore how experts look into the various features of any subject, which is available in the literature. This method allows experts to discuss other related topics and ideas, which may shift or expand the direction of the research within the established scope [224]. Some limitations of interviews include the variation in the knowledge of experts in conveying their ideas and responses. Another drawback is related to the researcher's potential to bias the responses of the participants [224,232]. To minimize this error, an interview protocol was developed, which was adhered to for each interview. Moreover, the reliability of the information collected through interviews was triangulated using the results from the document analysis, which were already collected, and by referring to new documents related to the subject.

The results of the document analysis was used to formulate the interview questions. All of the major codes selected through the selective coding were given importance while framing the questions. Different aspects of ITM were also considered while formulating the questions for the semi-structured interview. Questions used for the semi-structured interview are presented in Appendix A7.

For gathering opinions, four experts were identified and interviewed in the first step based on the purposive sampling method. Later, as per their recommendations, the interview of two more experts was also conducted. Among the experts, four Kuwaiti Ph.D. holders and two engineers (one British national and one Indian), with more than twenty years of experience in the Kuwaiti electricity market, were included. Grounded theory-based coding was performed for this stage also. The responses of all experts were recorded individually by a voice recorder and labeled accordingly. All of the interviews lasted a minimum of one hour and well addressed all of the concerns raised. Line by line transcription of the audio file was carried out soon after the completion of each interview, and the transcripts were coded with the help of ATLAS.ti software. The coding process carried out was similar to the document analysis (Fig. 5.5). Both in vivo and manual coding methods were adopted at this stage [226]. By the end of the sixth interview, code saturation was experienced as no more new information could be gathered. Accordingly, the interview process was terminated. More information on newly added parameters was collected from literature to increase the knowledge base on these factors.

All of the identified 276 codes were used to prepare axial coding, similar to the document analysis. The complete code list, which includes the theoretical coding and the codes related to the framework, is presented in Appendix A8. After performing the selective coding, mapping of codes was carried out by integrating them with the existing selective codes identified during the document analysis. By performing a well-focused theoretical coding, all ITM related information was arranged together to make a story line, which was capable of strengthening the theoretical premise. The details of the newly identified codes and theoretical coding, along with their importance, are given in the results and discussions section.

As a combined result of objective 1, an implementation framework for introducing IBDR programs for KRS was developed. To check the acceptance of various IBDR programs among the consumers in the KRS, three IBDR programs were formulated. All of these programs were developed based on the recommendations of the experts. Out of the three, two programs are DLC based, and the third one is DBBB based. Experts ruled out the possibilities of introducing IL-based programs in Kuwait. The developed programs are named as remote controlling of selected load (RCSL), summer vacation program (SVP), and quick bidding program (QBP). All of these programs are formulated with two different pricing methods. The details of these programs are given in the results and discussion section. The acceptance of these programs in the KRS was judged by the second objective of the research study.

5.4. Objective 2: To study the acceptance of the different incentive-based demand response programs by the consumers of Kuwait’s residential sector

The second objective of this study focused on the acceptance of the proposed IBDR programs by the consumers in the residential sector of Kuwait. For this purpose, information was gathered directly from the consumers through a survey. Surveys are widely conducted among a large number of people to collect their response and opinion on a particular subject. The survey is a very cost-effective way to collect information from a large number of people [233]. The preparation of a well-focused questionnaire is the main building block of survey-based data collection.

5.4.1. Preparation of questionnaire

To collect the required information, a detailed questionnaire was prepared and arranged under four broad areas, such as introduction, general information, programs, and general feedback. The details of each category are presented in Table 5.2.

Table 5.2. Details of the questionnaire

Section No.	Heading	Contents	No of questions
1	Introduction	A detailed description of background, aim, confidentiality, etc., are detailed here.	Nil
2	General information	Different demographic information, such as age, nationality, type of building, the location of house, income, etc., was asked to enter. Data format: dichotomous, and open-ended, multiple-choice.	13
3	Program-1 RCSL	After detailing the highlights of the program, participants' interest to participate in the program and their proposed load reduction potential under two different incentive schemes were asked to enter. Data format: Likert scale.	4
4	Program-2 SVP		5
5	Program-3 QBP		4
6	General feedback	Along with general feedback on the proposed programs, the most preferred program and incentive schemes were asked to enter. Data format: dichotomous, open-ended, Likert scale.	4

Questions 1 to 13 were intended to collect the demographic information of the consumers. Following that, different programs and incentive schemes were introduced to the consumers to register their interest in participating in such programs (questions 14 to 26). Finally, through the questions in the general feedback section (questions 27 to 30), consumers' overall view about different programs and incentive schemes was collected. By considering the nature of participants, the questions were presented in both English and Arabic languages. The finalized questionnaire (Appendix A16) along with explanation is presented in the results and discussion section.

5.4.2. Sampling

The required data collection for this study was carried out using a survey, which involved a structured questionnaire given to respondents for eliciting information required for making a satisfactory conclusion. Data collection was carried out based on the random sampling method to collect data from all governorates of Kuwait. The population of the sample includes consumers residing in different types buildings in the different governorates of Kuwait. The source of data can be considered as the primary data since it was collected directly from residential consumers. Sampling size was calculated based on [234] the formula:

$$n = \frac{N}{1 + N(e)^2} \qquad \text{(Eq. 5.1)}$$

where N is the total population and e is the confidence level. While substituting the values, N as 4480000 [235] and e as 0.05 (for 95% confidence level), n comes as 400. A 95% confidence level is widely accepted in all social science related studies [218].

Even though different administration methods can be used for collecting the responses [236] from the consumers, by considering the technological development in the country [237], Internet-based online survey method was adopted, for which a subscribed version of SurveyMonkey software was utilized [238].

5.4.3. Statistical tests

Data analysis using Statistical Package for the Social Sciences (SPSS) version 21 was proposed for analyzing the collected data. SPSS Statistics is a software package used for the statistical analysis of data. SPSS was initially developed by SPSS Inc., and the name was changed to IBM SPSS in 2010 [239]. The following analytical methods were planned to test the results.

- Chi-Square test was planned to check the association between consumers' willingness to participate in different programs and targeted load reduction.
- Mann-Whitney U test was used to compare the participants' willingness based on two groups, "not interested" and interested" in load reduction.
- McNemar's Chi-Square test was used to check the association between different incentives offered to consumers and their willingness to join in the programs.
- Frequency distribution was used to check the most preferred incentive scheme based on the preference of participants.
- Frequency distribution was used to evaluate the most preferred program based on the preference of participants.

The Chi-Square test is commonly used by statisticians to check the dependency of two sets of data to clarify whether two attributes are associated or not. This test can easily be carried out using the popular statistical software, SPSS. Always the initial assumption will be both the variables are independent and there is no association between them. Accordingly, the null hypothesis will be formed. From the data, the software will calculate two values, namely, "calculated value" and "expected value", as the first step to compute the Chi-Square value. If the "calculated value" is found to be less than the "expected value", at a selected level of significance and degree of freedom, it can be concluded that there is no association between two variables, and the null hypothesis will be accepted. In the other scenario, where the "calculated value" is more than the "expected value", it can be assumed that there is an association between these two variables. In this case, the null hypothesis will be rejected, and the alternate hypothesis will be accepted [218]. In this study, the Chi-Square test was planned to check the association between consumers' willingness to participate in different programs by accepting various incentives for their load reduction. The initial assumption for this case was that both of these attributes are independent; accordingly, the null hypothesis was formulated. By using the SPSS software, the test was intended to be carried out for all the three programs for various incentive schemes in every time period.

Man-Whitney U test is a well-liked rank sum test, which is used to identify the ranking of two groups of variables in a given set of data. The null hypothesis followed in the Mann-Whitney U test is that there is no difference in the appearance of two groups in the data [218]. It is expected that participants who engaged in the survey will be having different opinions about the program and based on their interest, responses can be clustered into two groups such as "interested" and "not interested". In this study, with the help of SPSS, this test was used to find out the most prominent group of consumers in the collected data. If there is no substantial change between the rankings of these two groups, the null hypothesis will be accepted, assuming that both the groups are identical. If the ranking has a substantial change, the null hypothesis will be rejected, and the alternate hypothesis will be accepted. However, the interpretation will be based on the ranking. If the rank for the "interested" group is significantly higher than that for the "not interested" group, it can be assumed that most of the consumers support IBDR programs, which is a positive gesture for the policymakers to proceed further. In the other case, if the "not interested" group is prominent, it can be assumed that the implementation cannot be carried out in the present format and the reasons behind the lack of interest has to be investigated.

McNemar's Chi-Square test is widely used for making some assumptions based on the same variables as "before-after" situations. This test is used to assess the impact of certain measures taken by comparing data collected in two stages: before and after the action [218]. By seeing the analyzed results from the SPSS, the effect of the action can be assessed. Similar to other tests, the null hypothesis for this test also rules out the impact of the action, while alternate hypothesis argues that the impact is significant. In this study, the first set of data (before data) was based on the consumers' interest toward IBDR programs with the first type of incentive, and the second set of data (after data) was the interest after changing the incentive scheme. By conducting this test, the researcher can identify the impact of changing the incentive schemes on the consumer''s interests. Accordingly, the programs can be modified to include/exclude certain incentive schemes.

The repetition of the variable in a data set is termed as frequency, and from category wise count of the occurrences within a particular group, the distribution of data in different categories can be examined [240]. SPSS can easily prepare frequency tables to show the people's response to various choices. In this study, frequency distribution was taken as a measure to mark participants' preferences for different IBDR programs and incentive schemes. Two dedicated questions were included in the questionnaire for this purpose.

The details of the above analysis are explained in the results and discussion chapter.

5.5. Summary

Combinations of different methodologies were followed to achieve the research objectives addressed in this study. The research methodology adopted here is a combination of qualitative and quantitative data analyses methodologies. The methodology designed to meet the first research objective was based on framework analysis and grounded theory and was prepared in two phases. The first phase was based on the document analysis and the second phase was based on experts' interviews. The step-by-step explanation of the methodology is presented with the help of a flow diagram. The coding process was carried out for both phases with the help of a popular qualitative data analysis software, ATLAS.ti. A dedicated flow diagram is presented to show the different steps involved in the coding process, supported by a detailed description. By completing the first objective, a clear framework for implementing new IBDR programs was formulated, and three different IBDR programs were suggested to suite Kuwait's electricity market. As part of the second research objective, to check the acceptance of the proposed programs among the residential consumers of Kuwait, a survey-based research methodology was developed. Accordingly, a questionnaire was prepared to cover different aspects of consumers such as demographic information, response to programs on different time frames and incentives, and general feedback. By using SPSS software, various statistical analyses, such as hypothesis test, McNemar Chi-Square test, Mann-Whitney U test, and frequency distribution of choices, were proposed to analyze the feedback received from consumers. The results obtained for both of the research objectives are detailed in the next chapter.

6. RESULTS AND DISCUSSIONS

6.1. Introduction

In this chapter, the results obtained by conducting various analyses are discussed. The results are arranged in two sections. In the first section, the results of the first objective are discussed, which include the outcome of document analysis and experts' interviews. In the second section, the results of the second objective are discussed.

6.2. Results of sequential analysis (objective 1)

The results of the first objective of the study are arranged in four parts. In the first part, the results of the document analysis are presented. These results are focused on the information gathered from different documents. In the second part, the results of the experts' interviews are given. A combined outcome of both document analysis and experts' interviews are provided in the third part. All of the information pertaining to the theoretical premise are presented in the last part.

6.2.1. Results of document analysis

The results of the document analysis contain the interpretation of various observations made from the 35 files prepared as part of the indexing stage. ATLAS.ti software was used to extract all possible codes from these 35 files. By following the thematic framework (Fig. 5.4), all of these codes were mapped via axial coding under five broad categories: features, benefits, pre-implementation, implementation, and post-implementation, which are detailed in the subsequent sections. The complete pictorial representation of axial coding for these stages is given in Appendices A9 to A13. As features and benefits are already discussed in the previous chapters, the other three major components, which are the backbone of the implementation framework, are detailed in the subsequent sections.

6.2.1.1. Pre-implementation stage

This stage discusses the preparation phase of the framework. Fig. 6.1 shows the outline of the pre-implementation stage. The different codes are further arranged under three subcategories such as challenges, requirements, and activities. These categories were developed based on the repetition of codes and their importance. The detailed explanation of each code is given subsequently.

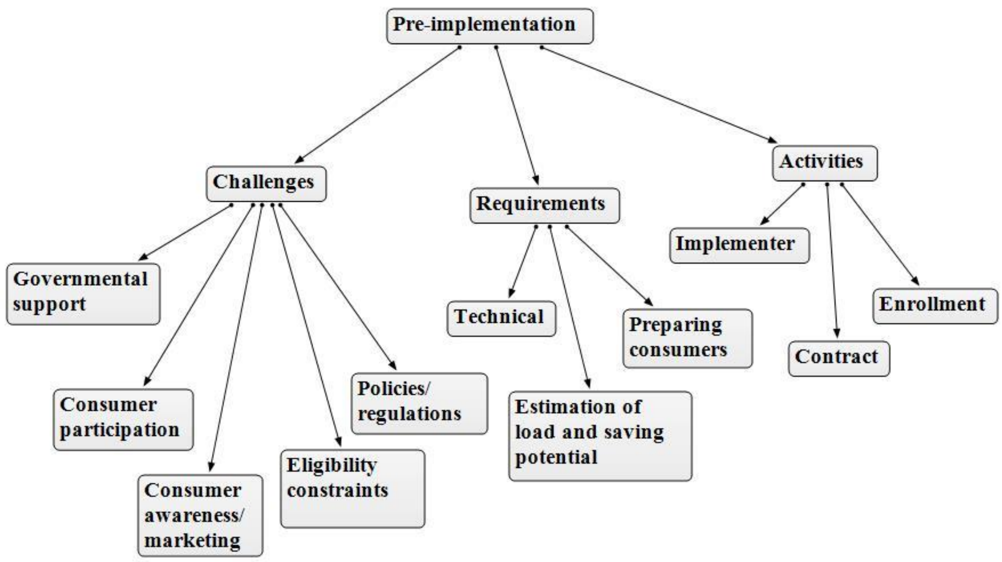

Fig. 6.1. Outline of the pre-implementation stage

6.2.1.1.1. Pre-implementation challenges

After analyzing the codes under the category challenges, it was learned that during the pre-implementation stage, factors, such as the procurement of governmental support, ensuring of consumer participation, creation of awareness among the consumers, impressive marketing of different IBDRPs, eligibility criteria, and the importance of policies and regulations, needed to be addressed. Their details are explained subsequently.

6.2.1.1.1.1. Governmental support

Without governmental support, the implementation of IBDRP may not be possible in any electricity market. The government can help the DSM program by introducing policies for its implementation [241,242]. As residents are liable to follow laws and policies introduced by the government, a well-developed DR policy can be implemented efficiently. Different stakeholders can refer to it and get directions for their future installations and implementations.

Before the implementation of any power reduction strategy, it is required to make facilities to measure the power profile of buildings. For calculating the amount of load reduction on the different time periods, SMs are widely used. Compared to traditional meters, SMs have many advantages, which will be helpful to quantify the reduction in power consumption. The government can take necessary actions to replace traditional meters with SMs to enable DSM implementers to start with [241]. By keeping the option for the possession of SM as voluntary, the implementation of DSM measures may not be possible, as consumers may not have much benefit in spending the extra money for buying SM. Even if the usage of SM is kept as mandatory, the government should make sure that it supports financially weak people to procure SM. There should be clarity on who will bear the cost of the procurement and installation of these meters.

The government may take initiatives to establish a national forum to discuss the various aspects of implementing DR policies in the country [243,244]. Different stakeholders, such as generation companies, distributors, utility companies, state legislators, consumer representatives, etc., may be included in the forum. Since IBDRP is a new concept to many markets, proper arrangements should be made to give reasonable awareness and training to different stakeholders and decision makers [97,243]. By arranging technical sessions, introducing new knowledge as well as transferring available knowledge to all stakeholders can be efficiently done. The government may also support research projects in the field of IBDRP.

The participation of private sector is vital to the success of DR programs. The government should take necessary measures to transfer knowledge and boost the confidence of the private sector. A centralized body comprising experts on the different stages of IBDRP, from design to measurement and verification (M&V), can be formulated. This will be useful for knowledge transfer and providing solutions to different problems faced by various subunits such as state boards in the USA context.

As communication is one of the pillars of the IBDRP, to avoid conflicts between the various communication protocols, a national communication program can be developed by the government [243]. Similar to DR policies, standards and protocols should also be developed /updated and made available to all by keeping them in a centralized location and sharing via a website. Any person interested to know more about the rules and regulations should be able to get all required information from these websites [97,243]. To protect consumers' interest and the transparency in the incentive distribution, the government should take necessary steps to invigilate the entire process. This applies to markets where a lot of private players are available [243,244]. In other areas, the government can consider giving subsidies and financial support to implementers, making participation in DR programs mandatory for all, ensuring the financial security of the implementing agency, if applicable, etc. [114].

6.2.1.1.1.2. Consumer participation

Success and failure of any DR program are highly dependent upon the customer participation. Hence, it is identified as one of the significant challenges and has to be tackled before any other parameter. Some of the influencing parameters determined are detailed subsequently.

Most of the IBDR programs require the installation of some additional hardware such as programmable thermostat (PTS), and occupancy sensors, into the existing system. It is the prime duty of the implementing authority to guarantee the availability of such hardware (both quality and quantity). Consumers should not struggle to procure the required hardware for participating in DR programs [245].

In certain IBDRPs, implementers remotely control consumers' appliances such as AC units, refrigerators, washing machines, cloth dryers, etc. If the consumers are not willing to accept these types of remote controls, the implementation of such programs cannot be carried out. Consumers' willingness needs to be assured before enrolling them for the program to avoid future problems [241,242]. One of the prime features that impact the consumers' participation is related to the compensation that they receive in return for their compromise on electrical consumption. Studies emphasize the importance of motivating consumers for ensuring their participation in DR programs. Participants widely accept incentive-based motivations, which are the backbone of IBDRP. Incentives are classified as MIs and NMIs. Depending on the consumers, their interest in different types of incentives may also vary. Consumers can be attracted to the DR program if the offered incentives are adequate to compensate the discomfort experienced by the consumers. It is also noticed that in some cases, load-based incentives are provided to consumers as compensation. For example, in hot areas, consumers who are willing to switch off the AC units are given more importance than those who are ready to turn off other regular appliances such as washing machines and dishwashers [97,241,242].

It is not necessary that incentives can ensure the participation of all consumers. Some consumers may have different preferences. Some of the environmentally conscious consumers may volunteer themselves to the program without accepting any reward [97]. Encouraging volunteer participation will bring many benefits to the implementing agency.

It is natural that consumers may exhibit some resistance to change in their electricity consumption pattern. By clearing all of the doubts raised by consumers, the implementing agency can influence the consumers positively. In the absence of a national policy for technologically upgrading the household equipment to a minimum level of energy efficiency, consumers may have to bear some expenses to upgrade their equipment to meet the minimum requirement of IBDRP. By considering the financial status of different consumers, support can be offered to financially weak consumers [242]. Some consumers may demand a long-term plan and commitment for the incentives, which may be difficult for implementers to offer in advance [2]. Tailoring the contract can be considered in such cases to ensure consumer participation. For most of the consumers, job, family life, health, schooling, etc. are more important than EE. Elevating the priority of EE is another challenge that has to be taken care of [246].

6.2.1.1.1.3. Consumer awareness/marketing

Awareness and marketing play vital roles in enrolling new consumers into different IBDRPs. Before the process of enrollment, proper awareness has to be given to consumers on the aim and benefits of the proposed program. It is imperative to know the type of loads used in the household, before suggesting any program to the consumers [114,241,242]. Also, implementers should find a way to meet the required expenses [247]. Table 6.1 summarizes the most commonly used channels for creating awareness and marketing different DR programs.

6.2.1.1.1.4. Eligibility constraints

Most of the IBDR programs keep some guidelines for participation and set some minimum criteria for eligibility. The most important eligibility constraints noticed from the referred literature in most of the markets are minimum power reduction capability [128,248–250] and willingness to participate [251–253]. If the facility does not have the potential to reduce consumption, there is no point in including it in the program. Similarly, participants should have a minimum knowledge of program and related information such as benefits, control events, the number of events, and risks involved. Depending upon the program requirements, participants should be willing to allow remote controllability and M&V. With the help of a survey, consumers' willingness toward energy reduction and sustainability can be evaluated [16]. Additionally, all participants are liable to adhere to some contractual commitment [250,254], in which consumers' commitment to curtail their load will be documented, along with factors such as incentives, penalty, the number of control events, etc. In some cases, consumers should have some financial strength to upgrade their devices and equipment to suit the program [244].

Table 6.1. Widely used channels for awareness/marketing

Channel	Description	Reference
Call center	A type of telemarketing with the help of a technically qualified team.	[255]
Community education campaign	Catchy slogans, which will be registered in the minds of consumers, are the main attractions of the community education program, e.g., “Beat the Peak” used by ESTA, Australia.	[114,244,255]
Customized marketing messages	Target consumers based on their language, income, environmental consciousness, etc.	[255]
Direct mail	One of the most widely used methods, due to the capability to transfer detailed information.	[242,246,255, 256]
Face-to-face meeting	One of the most efficient but time-consuming and expensive methods.	[242]
Local advertising	Distribution of materials to people in places such as post offices and shopping malls, public transport systems, etc.	[242,255]
Local events	Small events arranged in public places to attract people.	[242]
Mass communication media	All popular mass communication media, such as television, radio, and press advertisement, can also be used to increase awareness/marketing of the program.	[242]
Social media	Due to the increased acceptance and influence among the young people, social media can be utilized efficiently.	[242]
Special offers and gifts	One of the commonly used traditional marketing methods.	[255]
Third parties	Involvement of nonprofit organizations, charity and community organizations, etc.	[242]
Website	Users should be able to use this as a proper platform to gather all information regarding different programs including laws, guidelines, regulations, tariffs, etc.	[243]
Word of mouth	This does not require any effort from the implementers. If the programs are good, consumers may suggest them to their friends.	[255]

6.2.1.1.1.5. Policies/ regulations

Most of the electricity markets meet the load demand by SSM and have not yet accepted DR as a resource. They may require more time and awareness to admit DR as a reliable electricity resource [2,257]. Overcoming problems due to the lack of proper regulations and policies is a big pre-implementation challenge in many countries, which are new in implementing DR. For example, the recording of electricity consumption using technologically advanced SM with data transfer facility is a fundamental requirement for any DR program nowadays. Without a proper policy on the installation of such devices, ensuring the availability of SM in every household would not be possible [241]. Similarly, a proper policy has to be developed to restrict the manufacturing/importing of less efficient electrical appliances [244]. It is also essential to define the roles of various stakeholders involved in the DR activities to avoid future problems [244].

Electricity consumption in residential buildings is directly related to the type of equipment used and their operating hours. When compared to big independent houses, the power consumption of apartments is considered low, and the potential of load reduction is limited. With the help of the aggregator, a third party, who acts between suppliers and consumers, the residents of the same neighborhood can collectively achieve the required demand reduction [258]. However, proper guidelines have to be developed to ensure the clarity of aggregator's role in areas such as prequalification, incentives, etc. [257]. As the reduction due to any DR program is calculated based on the CBL, its establishment is highly critical. Any error in this calculation may end up with underpayment or overpayment for consumers, which is not favorable to either consumers or implementers. A proper policy needs to be developed to meet this challenge [257].

Different implementers in the USA adopt various methodologies for calculating CBL. While PJM collects the readings of the four highest demand days during the last 45 days and takes the average of them [259], NYISO calculates the same with a 30-day data [260]. The calculation of CBL by

California Independent System Operator (CAISO) and Independent System Operator New England (ISO-NE) depends upon the average load for the previous ten days to implementation [261,262], whereas ERCOT developed a statistical model for CBL calculation [263]. From these, it is evident that there is no standard methodology to calculate the CBL, and all implementers should develop CBL, based on the nature of their program. At the same time, CBL cannot be generalized for all seasons. For example, CBL calculation for regular summer days should be different from that during the vacation time of the consumers. Continuous M&V should be performed to ensure the accuracy of the CBL. In DR programs where aggregators are involved, they guarantee the necessary reduction if one of the end users fail to curtail the load. This will shield the participants from penalties [264].

6.2.1.1.2. Pre-implementation requirements

Likewise the formation of pre-implementation challenges, the primary pre-implementation requirements are classified under technical requirements, estimation of load reduction and savings potential, and preparing of consumers. These areas are detailed in the subsequent sections.

6.2.1.1.2.1. Technical requirements

To match with the technical suitability of the control and monitoring devices, some technical prerequisites need to be ensured. Without securing such necessities, enjoying the full benefits of the program becomes doubtful. Even though energy efficient loads [55,90,265–269] are not mandatory for DR implementation, it becomes a vital part of the program. If the loads that are controlled are not energy efficient, they will consume more electricity than they are supposed to take. For example, if the built-in temperature sensor of a WH does not cut off properly, the WH has to work for a longer time than necessary. Many initiatives are taken widely to ensure that all loads are energy efficient. Some of these initiatives are permanent decommissioning of old equipment, exchange of old equipment with energy efficient ones, promotion of energy star labeled appliances, and providing of discounts for buying energy-efficient appliances [270].

The selection of proper control devices is also crucial to ensure the appropriate power reduction. Control devices have to be used based on the type of loads [153,241,256,265,268]. They are divided broadly into two categories, namely, PTSs [242,245,256,271–273] and control switches [245,247,256]. Power savings in thermostatically controllable loads,such as WHs and ACs, can be achieved by controlling their temperature set points based on occupancy and use. Almost all loads working on electricity can be disconnected from and reconnected to supply by using control switches. However, this cannot be used for specific electronic loads. Some of the new AC units also come under this category [274]. In most of the cases, the control system comes as a built-in feature with the control devices. For a finite control, a specially designed separate control systems are installed in many applications [268].

One of the primary requirements for introducing any DR program is SM [2,97,277–281,153,241–243,245,255,275,276]. Compared to traditional meters, it has many advantages such as more accurate and timely bill generation, capability of remote reading, facility of retrieving historical data, provision for having additional in-house displays (IHD) inside buildings to alert the inmates regarding their consumption, capability of having time-sensitive pricing, contribution to the increase of grid efficiency, securing from malpractice due to human intervention, etc. [241]. An approved SM should have the minimum ability to record data every 15 minutes [276,282]. Communication is identified as another essential requirement. TWC between a central server and local controllers, and local controllers and control devices should be established. This would useful to receive feedback on the command from the load to the central server [97,153,241,242,247,255,268,283,284]. In some cases, the Internet is used for TWC between the building and the central server [29]. Similarly, TWC between implementers and consumers should be introduced. As cell phones [275,278,282,285–287] are widely used by most of the people, implementers may contact consumers either by sending short messages or through Internet-based applications. For specific programs, such as demand bidding, Internet connection may be mandatory for all participants. Furthermore, adding some of the facilities, such as energy management system

[242,243,288], home area networks [114,242,289], and IHD [241,242], will make the control and automation more efficient. However, it requires additional cost.

Along with the abovementioned requirements, some of the optional technical requirements, such as the integration of microgeneration units (including RE), electricity storage facility, etc., will make the programs more robust due to their load shifting capability [153].

6.2.1.1.2.2. Estimation of the load and the saving potential

Before implementing the DR program, it is required to know the peak load in the facility and the possible amount of load reduction [247,265]. Without understanding this, the implementation of DR programs will not be fruitful. Unlike the generation side, the demand for electricity is uncertain, and it needs to be calculated. Accurate load prediction is one of the prerequisites for any DR program. Many software programs are available now to carry out such exercises, with the help of several parameters such as household size, income, equipment characteristics, schedule, weather data, etc. [97,245,290].

As mentioned earlier, CBL cannot be measured directly, and there is no standard methodology to establish CBL [257,291,292]. It was observed in some instances that some customers artificially increased their base load during the time of establishing CBL, to claim that they have curtailed more load than actual. This will help them in getting more revenue [242,291,293]. Proper care has to be taken while handling this problem, or else implementers will end up paying more. M&V of the CBL in a continuous manner is highly recommended to overcome this issue [245,291].

6.2.1.1.2.3. Preparing consumers

Once the abovementioned eligibility criteria are met and the consumers expressed their willingness to join the IBDR programs, implementers should check and validate if all prerequisites are met by the consumers. Checklist given in Table 6.2 can be used as a reference to record the status of users and take adequate measures to prepare them.

Table 6.2. Checklist for preparing consumers

Prerequisite	Preparation	Reference
Availability of SM	Ensure proper monitoring and data transfer capabilities of meters.	[275,276,282, 294–297]
Minimum load curtailing capability: individual	Conduct a mock test to ensure capability.	[278,282,294, 298–300]
Minimum load curtailing capability: aggregators	Introduce aggregators, wherever individuals do not meet the prerequisite. Conduct a mock test to ensure capability.	[275,295,301]
Installation of control devices	Ensure access to consumer's premises to perform preventive maintenance (PM) and corrective maintenance (CM).	[302,303]
TWC for control system	Ensure effective communication with acceptable response time.	[97,153,241,242,247,255,268,283,284]
TWC between implementers and participants	Find out the most appropriate channel for communication and test its functionality	[282,294]
Ensuring the comfort of the inmates	Ensure that participants do not have any health issues such as asthma, emphysema, heart disease, respiratory problems, or inability to tolerate high temperatures.	[296]

6.2.1.1.3. Pre-implementation activities

In this section, the usual activities that are to be performed during the pre-implementation stage are summarized. The main activities were clubbed under three categories such as, the selection of the implementer, enrolling of consumers, and preparation of a contract, which are detailed as follows:

6.2.1.1.3.1. Selection of the implementer

Based on the electrical distribution topology, the programs can be implemented by different entities. In most of the cases, utility companies themselves implement DR programs [278,298,304,305]. If the area to be covered is large and workforce management is a daunting task, some utility companies give part of the work (mainly installation and maintenance related work) to contractors, by keeping the program administration within their scope [256]. When the load curtailment capability of an individual consumer is small, implementers can introduce aggregators [248,257,278,298,306] to club similar consumers' loads together and interact with utility companies. Roles of aggregators include negotiating with utility companies, communicating with utility companies and end users, collecting and distributing incentives, etc. Whenever utility companies initiate an event, aggregators are responsible for curtailing the load after communicating with end users [289,306]. Aggregators are also helpful to end users, who cannot trade directly in the electricity market [257]. Due to the high diversity in load of the different participants, aggregators can manage the DR events, even if some of the participants fail to respond [257,290].

Additionally, other agencies, such as private-public partnership [58,243], third parties [242,243,256,307,308], nongovernmental organizations [243,244,309], etc., are also engaged in the implementation of DR programs.

6.2.1.1.3.2. Enrollment

The expected outcome of effective marketing/awareness campaign is enrolling more consumers into the DR programs. It is essential to make sure that all of the participants have fulfilled the prerequisites mentioned in the eligibility section. Some parameters, such as the type of electrical connection (three phase or single phase), the ratio of peak power to annual energy consumption, electricity bill, etc., are required to be considered before enrolling consumers. Most of the information is gathered with the help of personal interviews with participants or through a survey questionnaire [310].

Many methods are used to enroll consumers. Some of the commonly used channels are websites [249,275,303,311], call centers [286,311,312], mail-in cards [256], venues of mass campaign [75,313], etc. The significant factors that influence the enrollment of consumers for the program are summarized in Table 6.3.

Additionally, in some cases, customers are forced to enroll as an "opt-out" approach [256]. This type of forced enrollment takes place mostly in multistoried apartment buildings, where building owners are committed to DR programs, and all of the tenants are enrolled automatically.

6.2.1.1.3.3. Contract

DR contracts are different from electricity supply contracts [314]. To implement any DR, an agreement should be made between the implementer and all of the enrolled participants through a decent and well-written contract [253,275,276,294,315]. Designing of the contract is done by different stakeholders such as policymakers, grid operators, LSE (utilities and retail electricity distributors), etc. [97]. Aggregators should have two contracts, one with the utility company and the other with the end users [276]. Different conditions, such as the provision for termination [275], minimum contract period [296], necessary permissions for free access to premises [249], details on incentives [316], number of events [241], number of allowable overriding facility [246,317], etc., need to be included in the contract.

Table 6.3. Key factors influencing enrollment

Factors	Description	Reference
Type and level of incentives	Depending on the type of consumers, their interest in incentives may also vary.	[97,242]
Notice duration	The amount of time given to participants to curtail load may vary based on the type of program.	[97,318]
Frequency of events	Directly linked to the comfort of occupants.	[97,319]
Risks	Consequences related to the failure of curtailing the load	[97]
Effectiveness of program	The technical support offered by the implementers, effectiveness of marketing and awareness campaigns, etc.	[97]

6.2.1.2. Implementation stage

This stage is a continuation of the pre-implementation stage, where importance is given to the execution of the program. Although the challenges, requirements, and activities may vary based on the type of programs, this section focuses on the most common aspects of the implementation stage (Fig. 6.2).

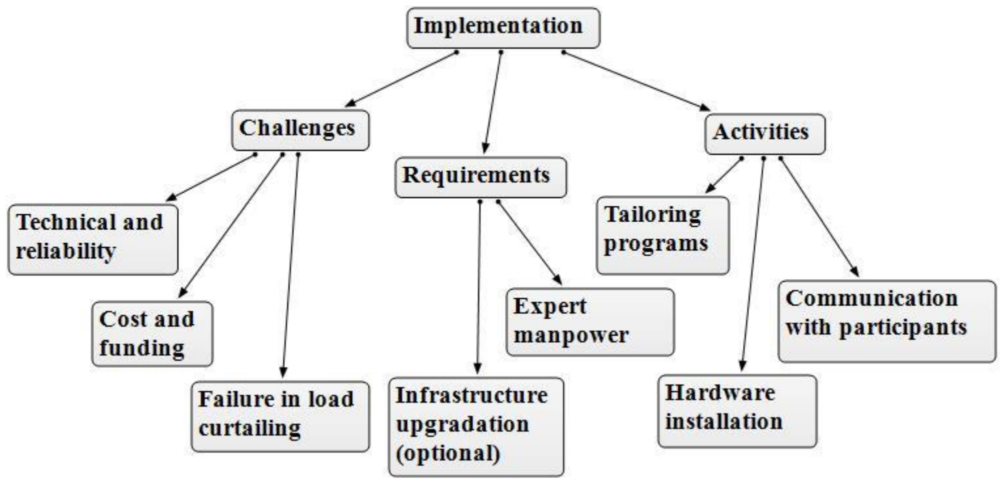

Fig. 6.2. Outline of the implementation stage.

6.2.1.2.1. Implementation challenges

The challenges grouped under the implementation stage are a continuation of its earlier stage. Among the challenges, cost and funding is the highly influential as it deals with revenue-related issues.

6.2.1.2.1.1. Technical/reliability

Even after designing a program carefully, several challenges may pop up during the implementation stage [153]. By ensuring the quality of products and their installation and by ensuring the reliability of communication system, some of the undesired events related to communication between devices and control systems can be avoided [247,320]. Many consumers may be suspicious about hooking up their electricity network to a centralized system, through SM and sophisticated communication networks [321]. For the successful implementation of the program, proper awareness has to be spread amongst the consumers to cooperate with the efforts to reduce electricity consumption, especially in public places such as office buildings, malls, commonly shared areas in an apartment building, etc. [287].

6.2.1.2.1.2. Cost and funding

Different costs are associated with the implementation of IBDRPs. Some of them are capital in nature, while others are operating expenses. These costs are arranged under two broad categories such as program cost and system cost. The program cost is related to the cost associated with the development of the programs and enrollment of participants, while the system cost refers to the expenses related to the infrastructure and technological developments. Major codes connected to these classifications are listed in Table 6.4.

System costs are further divided into initial system cost and operating system cost. In the initial system cost, all hardware related costs will be included along with the expenses toward consumer awareness. Depending upon the markets, the funding agency varies as summarised in Table 6.4. System operating costs cover all operational expenses starting from administration costs to incentive distribution costs.

In most of the cases, the system cost is funded by implementer or government, while the program cost is mainly met by consumers. Program cost deals mostly with the inconvenience caused to consumers while implementing the program. Depending upon the nature of the programs and contracts, the funding agency may vary.

6.2.1.2.1.3. Failure in load curtailing

Even though the implementing agency succeeds in enrolling new participants in the program, ensuring their involvement in executing the DR events promptly remains a nightmare for implementers. One of the primary reasons behind the failure is identified as the discomfort and inconvenience experienced by the participants [97,322–324]. People with disability and/or elder individuals in the family are found to be more affected by the DR events [242,322]. Consumers' comfort can be calculated based on the discomfort tolerance index [325], which can be improved with different strategies. Some advanced building management systems are capable of calculating the discomfort index [326].

Usually, loads are classified into three groups such as fixed, shiftable, and curtailable. Consumers divide their loads into these categories based on their preferences. For example, some people consider television as a shiftable load, as they can see the repeated version of a show later. However, for viewers who would be eagerly waiting for their shows, it is a fixed load. Any change in these priorities will influence the load curtailing capability of the consumer [327].

Some of the other reasons for program failures are forgetting an event [328], nonavailability of the implementer at the venue to implement the event manually [170], the failure in the communication of the instruction properly [78], difficulties in using new control devices [328], and negligence due to cheap electricity cost [329].

Table 6.4. Different agencies for costs and funding

Type of cost	Cost	Description	Funded by	Reference
System cost (initial)	Metering/ communication, system upgrade	The cost to meet the technological and installation requirements.	Implementers and government	[97,247,330–332]
	Control devices	Cost varies depending upon the programs.	Implementers and consumers	[97,247]
	Consumer education	Cost varies based on the methodology adopted.	Implementers and government	[97]
System cost (operating)	Program administration	The cost for the salaries of employees.	Implementers	[97,242,247,333]
	Marketing	Cost varies based on the method.		[97,247,333]
	Systems' integration	The cost of integrating different components.		[247]
	Call center	Costs for customer support.		[247]
	Maintenance	Cost of PM and CM.		[247]
	Data transfer charges	The cost to ensure secure data transfer.		[97,275]
	Incentives to participants	The cost of MI and NMIs.		[97]
	M&V	The cost to ensure that SM reading and calculation of CBL are accurate.		[242,333]
Program cost	Technological	The cost to meet the technological requirements.	Implementers, government, and consumers	[97,114,265]
	Strategy development	The cost for pilot studies and testing.	Implementers and consumers	[97]
	Comfort/ inconvenience cost	Opportunity cost varies based on the events.	Consumers	[97,242]
	Reduced amenity/lost business cost		Consumers	[97]
	Rescheduling cost	Expenses for overtime/ shift allowance paid to employees .	Consumers	[97]

6.2.1.2.2. Implementation requirements

Requirements during the pre-implementation stage are grouped into two categories: infrastructure upgradation and expert manpower.

6.2.1.2.2.1. Infrastructure upgradation (optional)

Although upgrading electrical infrastructure to smart grids is not mandatory for IBDRP, many implementers prefer to have smart grids for getting optimal results. The smart grid is a modernized electricity grid, which deals with the entire electricity chain, from generation to consumption [97,334–336]. With the help of integrated computer technology (ICT), it gains the ability to gather information from different points such as SM, sensors in substations, different grid equipment, off-grid data sets, home appliances, etc. [335]. ICT makes the information transparent among the various entities in the grid [191,336]. As the smart grid promotes competition, its importance is high in networks where multiple utilities are operating [73]. By upgrading to the smart grid, substantial improvements can be achieved in the overall efficiency [337] and reliability [337,338] of transmission and distribution [335,337], electricity consumption [337], and customer engagement [338]. With the help of smart grids, the integration of microgeneration units [337,338], which includes the integration of RE generators [265,338] and backup generators, can also be achieved.

6.2.1.2.2.2. Expert manpower

A well-trained technical and administrative staff is required for implementing an emerging technology in any new market. Any investment made toward developing specialist workforce will result in developing a strong team, which will be capable of executing similar challenging projects in future [77,116,255,339–342].

6.2.1.2.3. Implementation activities

Some activities need to be carried out as part of the implementation process. This includes tailoring of the programs, communication with the participants, and hardware installation, which are elaborated as follows:

6.2.1.2.3.1. Tailoring programs

As each consumer is different, with respect to several factors including demographics, type of load, occupancy pattern, type of control algorithm, etc., proper tailoring of the program has to be done for its successful implementation. Table 6.5 summarizes the major factors to be considered while tailoring the program. Most of the tailoring is carried out based on the past experiences or on the results of the pilot studies [153].

Table 6.5. Major factors to be considered while tailoring the programs

Factors	Description	Reference
On-Off Cycling	Optimize the timing so that occupants do not notice the events (especially AC related operations).	[88,153,155,256,265]
Number of events	Develop total number of events built on maximum event period, total time of event in hours, the minimum gap between consecutive events, etc.	[144,241,256]
Control devices	Select the most appropriate control devices based on the load and occupants.	[256,343]
Mode of control	Select the most appropriate control mode based on the load and occupants (e.g., automatic, semiautomatic, and manual)	[328,343–347]
Time of control	Applicable in locations where the TOU tariffs are in practice.	[343]
Control groups	Control groups can be formed based on the load distribution and the total number of devices to be controlled.	[343,348]
Weather condition	As climatic conditions play a major role in the indoor comfort, this important parameter needs to be considered.	[349]
Overriding facility	Identification of the most critical control system for providing the overriding service.	[246,317]

6.2.1.2.3.2. Communication with participants

Communicating with participants on the event is vital for the implementation of DR programs. Any failure in this will lead to unforeseen results in the power reduction. There are different approaches adopted worldwide. Some of the major ones are as follows:

- Day-ahead notice [245,276,278,282,286,295,299,306,312,350]: Whenever an event is planned, the implementer has to inform the participants 24 hours prior to the program.
- Day-of notice [294,295,298,306,351,352]: In some cases, where electricity needs to be curtailed urgently, a 15 to 30 minutes' notice will be given to the participants about the event.

There are many channels used for communicating with consumers, such as telephone calls [353], short messages in telephones [275,278,299], e-mails [275,278,299], smartphone-based applications [354], etc.

6.2.1.2.3.3. Hardware installation

For most of the DR programs, one of the major physical works associated is the installation of hardware. There should be clarity on the cost involved, and the funding agency responsible for the purchasing and installation of the hardware [247]. Control devices, used to operate AC units, may have to be installed outside, subjected to the harsh environment. It is essential to confirm the quality of hardware so that control devices can withstand such weather conditions [255]. For the perfect installation and checking of their functionality, implementers may have to visit the premises multiple times. Proper permission and access to these premises need to be obtained well in advance to avoid delay [256].

6.2.1.3. Post-implementation stage

When compared to the other stages, more activities have to be taken care of at this stage. The outline of the post-implementation stage is shown in Fig. 6.3.

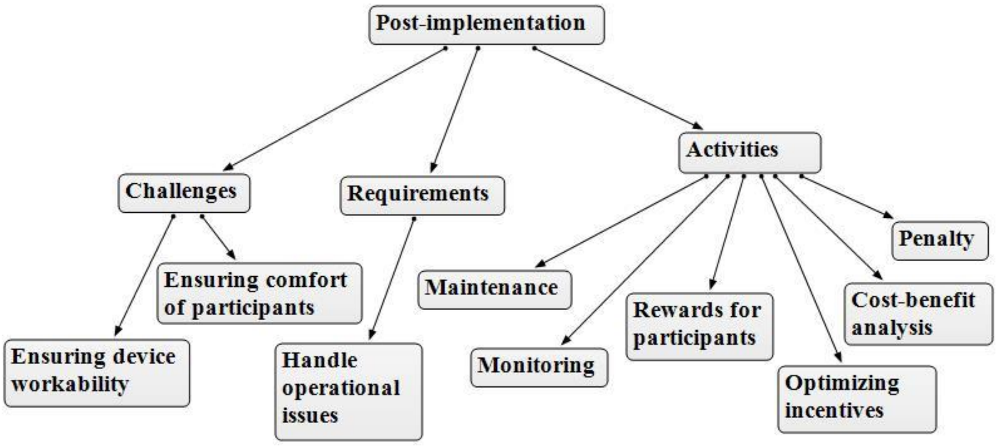

Fig. 6.3. Outline of the post-implementation stage

6.2.1.3.1. Post-implementation challenges

The challenges identified at this juncture are operational in nature. The major challenges include ensuring device workability and providing occupants' comfort, which are detailed in the following sections.

6.2.1.3.1.1. Ensuring device workability

Most of the implemented programs might fail if proper maintenance of various components in the system is not done periodically. Ensuring device workability is one of the main challenges of the post-implementation phase. One of the foremost causes behind the failure of the program is related to the communication breakdown between controllers and control devices. Chances of failure are higher in the case of one-way communication than in TWC [193,247]. The identification of faulty devices [247] is another major challenge to be handled efficiently. According to a study conducted by [247], 70 to 80% of device failures are related to their age and inability to identify their status on time. By performing continuous commissioning, problematic areas can be identified, and appropriate corrective measures can be taken on time [322]. By trending the data, faulty devices can be easily traced out [355], and all defective devices can be identified and replaced timely [356]. Essential devices, such as electricity meters, need to be replaced as soon as possible [79].

As the usage pattern of each load is different, especially AC loads that change with the user's behavior, a general control procedure may not be feasible to all participants. A lot of time and effort are required to develop a suitable control algorithm for each and every consumer [117,173,247,357]. This cannot be done during the pre-implementation and implementation stage.

The development of appropriate M&V is another post-implementation challenge [257,358]. M&V helps determine the energy reduction achieved by the programs [359]. To give incentives for participants, a proper M&V methodology needs to be developed so that participants' power reduction can be verified. M&V is a continuous process, which has to be conducted on a regular basis. One of the main challenges of M&V is to differentiate savings achieved from the program's implementation from the other factors, which help reduce the consumption [359]. By conducting M&V efficiently, implementers can guarantee the accuracy of CBL [257,360], power reduction as committed by the contract, proper communication between controllers and control devices, frequency interval of power readings, the accuracy of standards, product specifications, time of use [257], etc.

However, carrying out M&V effectively is not an easy task. Approaching consumers repeatedly for conducting M&V may result in the loss of consumers' interest in the program. They may feel that implementers are suspicious regarding their power curtailment. Compared to old and established programs, the cost involved in M&V will be more for the newly implemented ones [361].

6.2.1.3.1.2. Ensuring consumer comforts

Most of the consumers give a lot of importance to their comfort than the savings in their electricity bill due to power curtailment, environmental benefits, the incentives offered to them for power reduction, etc. The challenge here is to convince the customers to curtail their electricity usage without compromising their comfort. The identification and isolation of unwanted electricity loads, shifting some of the loads to nonpeak hours, etc., are some of the well-adapted methodologies. However, as far as the residential consumers are concerned, any reduction in the operation of AC load will be higher than the contributions from other loads. If consumers are willing to reduce the operation of their AC load, it will definitely have some impact on their comfort. In reference to the lessons learned from the past experience and pilot studies, AC cycling strategy needs to be developed to maintain the comfort levels. With the help of an AC cycling strategy, On-Off timing of the AC units can be varied [68,153,255,362–364]. At the same time, efforts should be made to increase the awareness of consumers to accept the change in comfort levels, considering the importance of the situation [242,256].

By conducting frequent surveys, implementers would be able to monitor the comfort status of the participants [256,362–364]. After analyzing the feedback, implementers may offer more control to users on their loads, by modifying the overriding facility [246,317], if required. Consumers can avail this overriding facility to run their equipment, which were committed to shutting down during a program event.

6.2.1.3.2. Post-implementation requirements

The main post-implementation requirements are the availability of expert manpower and facilities to handle various operational activities.

6.2.1.3.2.1. Handle operational issues

After the successful implementation of DR programs, it is required to make sure that the participants are not adversely affected by the programs. Some of the operational requirements are making events unnoticeable [265,365,366] and continuously updating strategies [130,367]. These targets can be achieved by ensuring the healthy functioning of the system by conducting M&V and maintenance activities, which require continuous interaction with participants [368].

6.2.1.3.3. Post-implementation activities

Proper planning has to be done to retain participants by implementing programs to meet the expectations of both implementers and participants. Some of the most important post-implementation activities related to maintenance, monitoring of the program, incentives and their optimization and cost-benefit analysis are detailed below.

6.2.1.3.3.1. Maintenance

To ensure interruption-free services, proper maintenance of the system is inevitable. Maintenance requirement of the system can be broadly listed under two categories [369]: PM and CM [247,369]. PM procedures are carried out while the system is still functioning. Proper scheduling of PM helps reduce the failure of the control devices and hence downtime [132,369,370]. CM needs to be carried out whenever a crisis arises. Emergency maintenance activities, such as restoring electricity to a facility, also come under CM [369].

6.2.1.3.3.2. Monitoring of the program

A continuous M&V methodology should be formulated to examine whether the implemented programs deliver the expected objectives [153,371] such as economic, technical, and quality standards. Since the reduction in the consumption cannot be measured directly, quantifying the actual savings needs to be done precisely with the help of CBL [311,332,359]. As all payments on power curtailment are based on the reduction from the CBL, the calculation of CBL is highly important [276,361,371]. By giving fair and accurate incentive payments [371,372], customer retention can be ensured.

Confirming the satisfaction of participants is one of the most crucial factors for fruitful program implementation. Satisfied customers are an asset to any business, as they may recommend the program to their friends [256]. By conducting surveys, the level of satisfaction can be measured, and proper actions can be taken to increase the satisfaction level [274]. Key factors to be monitored for ensuring consumer satisfaction include the quality of service provided [78], the effect of program optimization [373], and performance analysis [312].

6.2.1.3.3.3. Incentives for participants

The motivation for participants to join any DR program and actively involve in the events depends upon the incentives they receive in return. Incentives are classified as MI and NMIs.

- Monetary incentives: MIs are basically financial incentives [97,114,278,280,282,283,286,294,295,299,306,312,245,327,351,374–376,246,247,256,257,275–277]. Studies suggest that by providing proper financial incentives, more consumers may get attracted to the program [241]. In electrical markets, these incentives are provided through different ways such as monthly bill credits [97,256,275,282,286,294,306,312,351] and discounted electricity rate [114,306,327].
- Nonmonetary incentives: Unlike an organizational structure, the scope of providing NMI is not common in the electricity sector. Some of the practices adopted worldwide include free supply and installation of hardware (control devices) [246,256], free electricity during nonpeak hours [377], personalized consultation to explore the most suitable DR options [306], exception from power blackouts [301], etc. In some instances, some special privileges are also offered to participants.

6.2.1.3.3.4. Optimizing incentives

Periodic optimization of incentives is one of the continuous processes, especially applicable to newly implemented programs. The adequate distribution of incentives is required not only to make sure that users who follow similar strategies receive comparable incentives but also to optimize profits for the implementers. As a part of optimization, incentives need to be changed periodically. A lot of parameters, such as electricity price variation, weather condition, regional network congestion, the scale of reduction [378], the presence of aggregators, risk commitment [379], etc., should be considered while performing this activity.

6.2.1.3.3.5. Cost-benefit analysis

Cost-effectiveness is highly critical for attracting consumers to enroll themselves in the program [76,253]. The results of cost-benefit analysis depend upon the types of expenses included in the analysis [310,380,381]. It is tough to carry out the cost-benefit analysis of any DR program precisely, as it is integrated with many other expenses such as smart grid initiatives, SM, communication system, etc. [243]. If there is any simple straight method available to find out the cost that is associated only with the DR implementation, the calculation of cost-benefit analysis will become an easy task. The most commonly used costs for this analysis are capital cost and operational and maintenance costs [70].

Proper analytical methods have to be developed to carry out a cost-benefit analysis [97,382]. Some of the commonly used cost-benefit analysis methods comprise utilities test, participants test, total resource cost test, etc. [70]. It is evident that the results are also linked to the time frame and the level of power reduction achieved [88].

6.2.1.3.3.6. Penalty

All of the consumers enrolled in the programs are eligible for financial incentives. However, the imposing of penalties to those who fail to achieve the promised reduction depends upon the type of the program and the contract [264,275,276,286,295,383–386]. The main aim of imposing penalties is to ensure consumer participation [257]. The most common ways of imposing penalties are increasing the electricity price [275] or imposing a monetary penalty [257,385]. Continuous failure to curtail the load may force the implementer to reconsider the eligibility of the participant [257,275].

6.2.1.4. Selective coding of document analysis

Selective coding is the last stage of the qualitative data coding process. In this phase, all the identified themes and codes in the axial coding will have to be revisited, and a reduced number of codes will have to be selected to represent the entire codes, without losing their importance [387]. Accordingly, the total number of identified 328 codes was reduced to 42 essential codes, which are capable of explaining the crux of the document analysis (Fig. 6.4). During the process of selective coding, the themes like pre-implementation, implementation, and post-implementation were taken out along with their subthemes such as challenges, requirements, and activities.

From Fig. 6.4, it can be read that an electricity market can go for IBDR programs after getting proper green light from the government. Government support can be in the form of policy development, infrastructure upgradation to ensure the availability of SM and communication system for every consumer, funding, training of workforce, and approval of a trustable implementing agency.

With the help of appropriate channels, such as call centers, websites, and social media, implementers can give awareness to consumers for their participation in IBDR programs. However, for the enrollment, consumers should meet specific eligibility criteria such as willingness to reduce load, availability of SM, efficient load, appropriate control devices, TWC, and minimum load curtailing capability. Establishing CBL is one of the vital tasks during the execution of IBDR programs in any market. Consumers should be well aware of the procedure and should also extend their cooperation for the M&V processes, which are needed to be carried out regularly. Consumers should be mindful of the risks associated while joining the programs. However, consumer participation will depend on several factors such as the offered incentives, ensuring of comfort, the flexibility of the programs, data security, and other conditions in the contract. In both consumers' and implementers' point of view, a well-written contract is essential for the execution of the program. In the contract, the detailed information related to incentives, the actions to be taken if the consumers fail to respond to a program event, necessary permission to access the consumer's premise, etc., need to be mentioned accurately.

The outcome of the document analysis gave a general idea about how to proceed with IBDR programs in any of the new markets. However, the situation may change from market to market. As this study was intented to construct a framework for introducing IBDR programs in the electricity market of Kuwait, country-specific data collection and mapping of vital parameters with the existing results obtained from the document analysis was required to be carried out. Due to the unavailability of published reports on the feasibility of IBDR in Kuwait, it was decided to gather information from experts who have been working in the electricity sector for a long time. The next section details the results of semi-structured interviews.

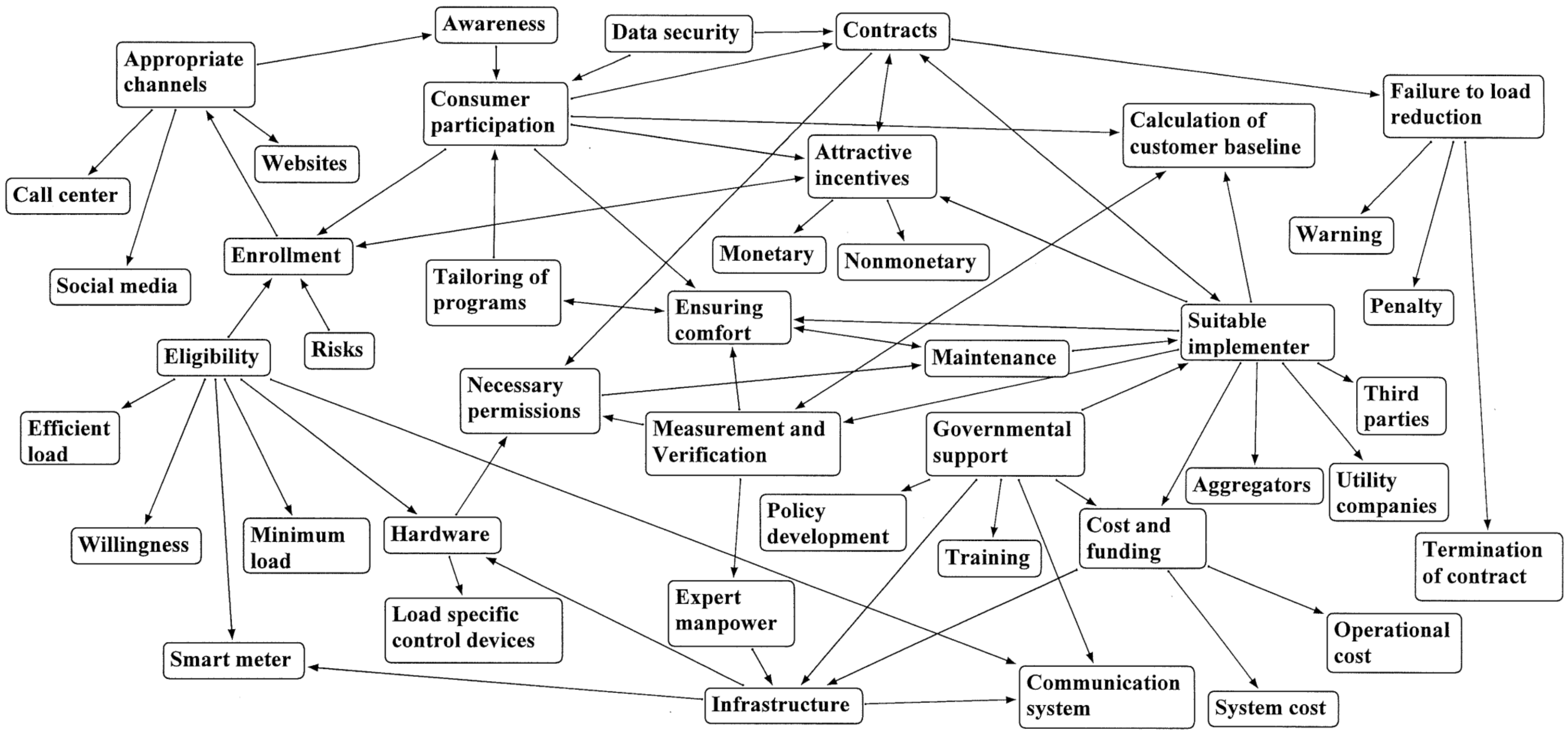

Fig. 6.4. Selective coding of document analysis

6.2.2. Results of semi-structured interviews

The outcomes of the semi-structured interviews are offered in three parts. In the first part, the general response of interviewees on introducing IBDR programs in the KRS is presented. In the second part, the results related to the new codes identified from the semi-structured interviews and their importance in the formulation of implementation framework are discussed. Additional information gathered from different documents on the newly added codes is also included at appropriate places for clarity. In the third part, the theoretical coding of the theoretical premise is discussed.

Six interviews were conducted at this stage. The experts were selected by following the judgmental sampling method. The selected experts accurately represented different stakeholders, such as the implementer, decision makers, consultants, and academicians. Code saturation was experienced when experts failed to provide new information. All of the interviews lasted a minimum of one hour and well addressed all the concerns raised in the interview protocol.

The responses of all interviewees were recorded individually by a voice recorder and labeled accordingly. Line by line transcription of the audio file was carried out. All six transcribed files were coded based on manual and in vivo approach after loading them to the ATLAS.ti software. Axial coding was conducted after identifying the relationships between the codes (Appendix A14). These semi-structured interviews not only helped to identify market-specific concerns but also helped to validate the collected data through document analysis.

6.2.2.1. General response of the experts on incentive-based demand response programs and Kuwait’s residential sector

All of the interviewees agreed that the electricity consumption is not optimized in any of the sectors in Kuwait. However, they strongly suggested that priority should be given to the residential sector, which consumes 60% of the total generated electricity [33]. Some of the advantages of selecting this sector would be the quick decision making capability of the residential consumers and the ability to judge the direct impact of IBDR programs. Even though the prediction of the expected savings was different from person to person, all experts were expecting a minimum of 20% reduction from the available consumption in the residential sector, provided the programs are adequately implemented. Even though the office hours are the most appropriate for the implementation of such programs due to the possibility of the nonavailability of inmates in their house, there is a scope for power reduction for the entire 24 hours throughout the year. Additionally, it was learned that most of the residents, irrespective of their nationality, travel out of the country during the summer period for a minimum of one month. However, this absence of inmates does not reflect on their electricity consumption effectively. Experts felt that the potential for power reduction during the vacation period is quite high and needs to be considered while developing any program.

Being new to DR programs, the government should support such programs without any restriction. The expected support includes policy formulation, cost and funding, and upgrading of the infrastructure. All residential dwellings should be equipped with SMs, and appropriate communication system for data transfer should be introduced. The collected data should be protected properly, and its use should be restricted only to billing and research purposes. By considering the Internet literacy, smartphone applications can be developed for communication purposes. Adding IHD units will also be beneficial to users for judging their electricity usage. Making appropriate modifications in the MEW code, to increase the level of automation in the buildings under construction, will be helpful to introduce IBDR programs easily in such buildings. Most of the experts recommended having an error-free CBL calculation based on a two-year historical base data. A model should be developed to calculate the CBL by considering different parameters such as electric power limit per unit area as per the MEW code, power demand in identical buildings, floor in the building, the orientation of the building, and the number of people residing in the house and their occupancy pattern. The optimal use of the GCC grid should be another area to be concentrated to avoid the unexpected failure of

IBDR systems. The effectiveness of the programs can be evaluated by analyzing the data collected from the SMs. The programs can be improved by taking the inputs from the consumers by conducting frequent surveys.

6.2.2.2. Newly identified parameters

From the interview results, some new parameters were identified, which were less discussed in the literature, but its importance was highly stressed by the experts. By adding the newly identified codes, the base network diagram was modified (Fig. 6.4 to Fig. 6.7) and the newly added codes were presented in a different color for better understanding. Additional information gathered from different documents on the newly added codes was also included at appropriate places to increase the clarity.

6.2.2.2.1. Awareness

Even though MEW has proved its capability for the mass campaign of EC, experts feel that establishing a dedicated ministry for handling various awareness programs would be beneficial for Kuwait. Through such a ministry, in addition to the MEW, the traffic department, and the Ministry of Interior can also spread the awareness about their respective programs in a centralized way. Nationality-based campaign with different languages will be beneficial due to the presence of the diversified expatriate community in Kuwait. As habits need to be developed from a tender age, school-based awareness programs need to be launched. If possible, the curriculum should be modified to create awareness for different programs.

6.2.2.2.2. Influencing factors for consumer participation

Getting acceptance for IBDR programs among consumers, who are enjoying the unrestricted availability of electricity for decades, was a matter of concern for most of the experts. As AC is identified as one of the basic necessities in this country during the summer period, which spans for almost nine months, fear of losing the comfort will be the main hindrance, which restricts consumers from enrolling to IBDR programs. In addition to that, other parameters, such as hidden costs, complications of programs, and handling the unexpected events, will also increase the fear of consumers and force them to abstain from enrolling in new programs. Moreover, as the electricity is highly subsidized, many of the consumers, especially who are rich, may consider the return for the sacrifice would be like “peanuts”. Experts also feel that some consumers may not be willing to commit to a repeated operational strategy, where their personal commitments are expected continuously. By considering the abovementioned factors, experts suggested conducting a detailed survey among the consumers to check their response to IBDR programs. Even if the responses are negative, experts felt that due to the benefits to the power generation sector and environment, the introduction of IBDR or similar programs will be beneficial to the country, and they advised to demonstrate the saving potential to consumers through some early adapters’ group. By considering the homogeneity of the consumers, pilot testing of IBDR programs using such group can be considered for demonstration purposes. However, consumer comfort should be considered as a high priority while demonstrating such programs.

6.2.2.2.3. Integrating renewable energy sources

Experts felt that the abundant availability of RES, specifically solar radiation, in the country should be harvested properly and utilized to the maximum possible way as an alternative energy source. The rooftop of the residential buildings should be utilized for the installation of solar panels. By encouraging consumers to install solar panels, the MEW can ensure that a part of consumers’ power requirements is met locally, for which all of the required technical support should be given to them from the design stage to the installation stage. Photovoltaic solar panels can be used to supplement the power requirement, while solar WHs would be useful to meet the hot water heating requirements during the winter season.

6.2.2.2.4. Factors to be considered while calculating the incentives

Experts felt that one of the expected questions from the consumers while approaching them for enrolling to IBDR programs will be related to the quantification of incentives, which can be offered to them in return for their participation and load reduction. Extreme care needs to be taken while developing the appropriate incentive schemes. As the fundamental aim of these programs is linked to the economic feasibilities, the dynamic calculation of the production cost high attention. Experts feel that similar to the MIs such as cash refund (CRF), NMIs can also be tried among consumers in the residential sector. This will enhance the interest of some consumers who are not much interested in CRF but willing to enjoy some other facilities. It was advised to formulate a credit account where points would be credited based on the time and amount of power reduction. Such accumulated credit point (CP) can be redeemed in various ways. Some of the hypothetically suggested ideas are special service counter (SSC), and lottery draw and special recognition (LDSR), special discount for energy efficient appliances and solar panels (SDASP). The details of these NMIs are given subsequently.

6.2.2.2.4.1. Special service counter

Most of the residents in the country need to visit governmental offices for various reasons. To save the waiting time, some exclusive windows can be reserved for those who have enrolled in IBDR programs. Consumers may redeem some of the accumulated CPs in return for the quick service. Depending on the necessity and demand, this facility can be extended to some other areas, such as airport, as well. Since this involves appropriate integration of different departments, a lot of preparation and coordination is required.

6.2.2.2.4.2. Lottery draw and special recognition

Most of the banks in Kuwait follow lottery draw-based strategies to attract consumers. Experts felt that by introducing such schemes, a lot of consumers can be attracted. However, more studies have to be conducted on calculating the prize value and the CPs required for entering the draw. Special recognition by the government authorities can also be planned for the consumers who reach a certain milestone of CPs.

6.2.2.2.4.3. Special discount for energy efficient appliances and solar panels

Due to the subsidized pricing and the unrestricted availability of cheap-priced low-quality electrical appliances, consumers are influenced to buy cheap products for saving money, which increase the power consumption. To control such unhealthy practices, giving subsidy for high-quality products can be considered. Linking such subsidies to the CPs that consumers gained, as part of their contribution to IBDR programs, will make a win-win condition for both the implementer and the consumers. In light of the support of experts for integrating RES in houses, the discount can be extended to solar panels also.

6.2.2.2.5. Suitable incentive-based demand response programs

Experts felt that among the proven IBDR programs, DLC and DBBP-based programs would be suitable to KRS and they expressed their unwillingness to accept the suitability of IL-based programs. According to them, as residents are not used to unexpected power failures, sudden interruption to the electricity supply in their premises will not be accepted by the consumers. While considering the number of families, both nationals and expatriates leave the country during the summer months; a specific program for the summer season would be beneficial and is expected to get more participation. There should not be any financial commitment to consumers and all of the maintenance-related activities should be carried out by the implementer. All programs should have an adequate overriding facility for handling unexpected events in the houses, which has to be clearly mentioned in the contracts. For the benefit of the implementer, accessibility to the premises should be granted by the consumer and should be mentioned in the contract. Even though experts rejected the idea of imposing any type of penalty on non-performing consumers, one of the experts suggested to increase the electricity tariff during the event period, which will indirectly act as a penalty for those who do not follow the contractual obligations.

6.2.2.3. Theoretical coding

The theory has an important role in the qualitative research and any contribution to theory is the end point of the qualitative study [232]. In this study, ITM was tested and improved by following the process of theoretical coding based on grounded theory.

The information that was related to the ITM, collected from the experts, was separately coded in ATLAS.ti and accordingly, 31 codes were identified under the process of axial coding (Appendix A15.), which were reduced to 11 selective/focused coding under two themes: barriers and enablers (Fig. 6.5). Based on the analysis, the following theoretical story line was formulated.

"In a subsidized market, people can be motivated by offering both MIs and NMIs. However, several barriers, such as fear, unwillingness, and indifference, are expected from the consumers' side. To an extent, this can be overcome by introducing appropriate enablers such as ease, quality, aid, adequacy, awareness, customization, interaction, and demonstration".

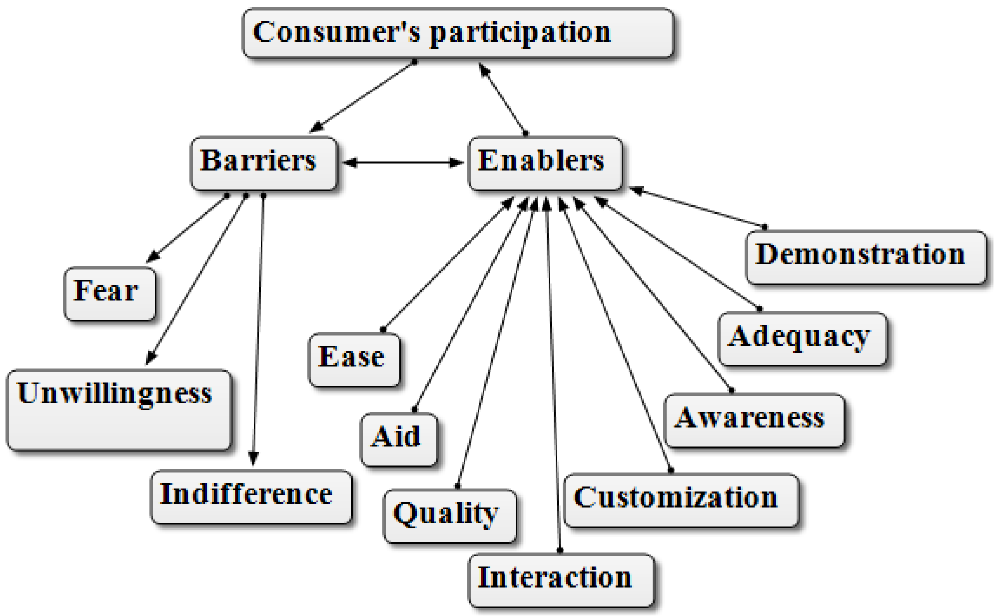

Fig. 6.5. Theoretical coding

6.2.2.3.1. Correlating the findings with the subsidized monopoly electricity market

This study conducted in the subsidized electricity sector highlighted the impact of long-term subsidized pricing on the behavior of consumers. Keeping aside the group of consumers who have high awareness and commitment to the environment, the other group is entered into a hibernation stage. Both MI and NMI-based rewards were proposed as extrinsic motivation to attract consumers for participating in IBDRP. Along with these, three major obstacles were identified, which have to be overcome to elevate the consumers from the stage of hibernation. These obstacles are fear, unwillingness, and indifference. In a subsidized market, both MIs and NMIs have importance. Among the NMIs, special privileges and recognition are found to be effective, leaving behind security and enrichment opportunities. The revised construct of the theory is given in Fig. 6.6.

6.2.2.3.1.1. Fear

Fear is mainly related to the expected compromise to be made by consumers in return for the incentives received by them for participating in IBDRP. The amount of comfort to be compromised in the indoor conditions would be a matter of concern for most of the consumers who are living in the arid regions, where AC is identified as a potential load for IBDRP. Another affecting factor related to fear would be the unexpected financial commitments required for installation/upgrading of equipment for the IBDRP. As many consumers are new to such programs, they may be more worried about the associated risks as well, which include the consumers' incompetency to handle sophisticated control systems, and the dependency for support from the implementer of IBDRP.

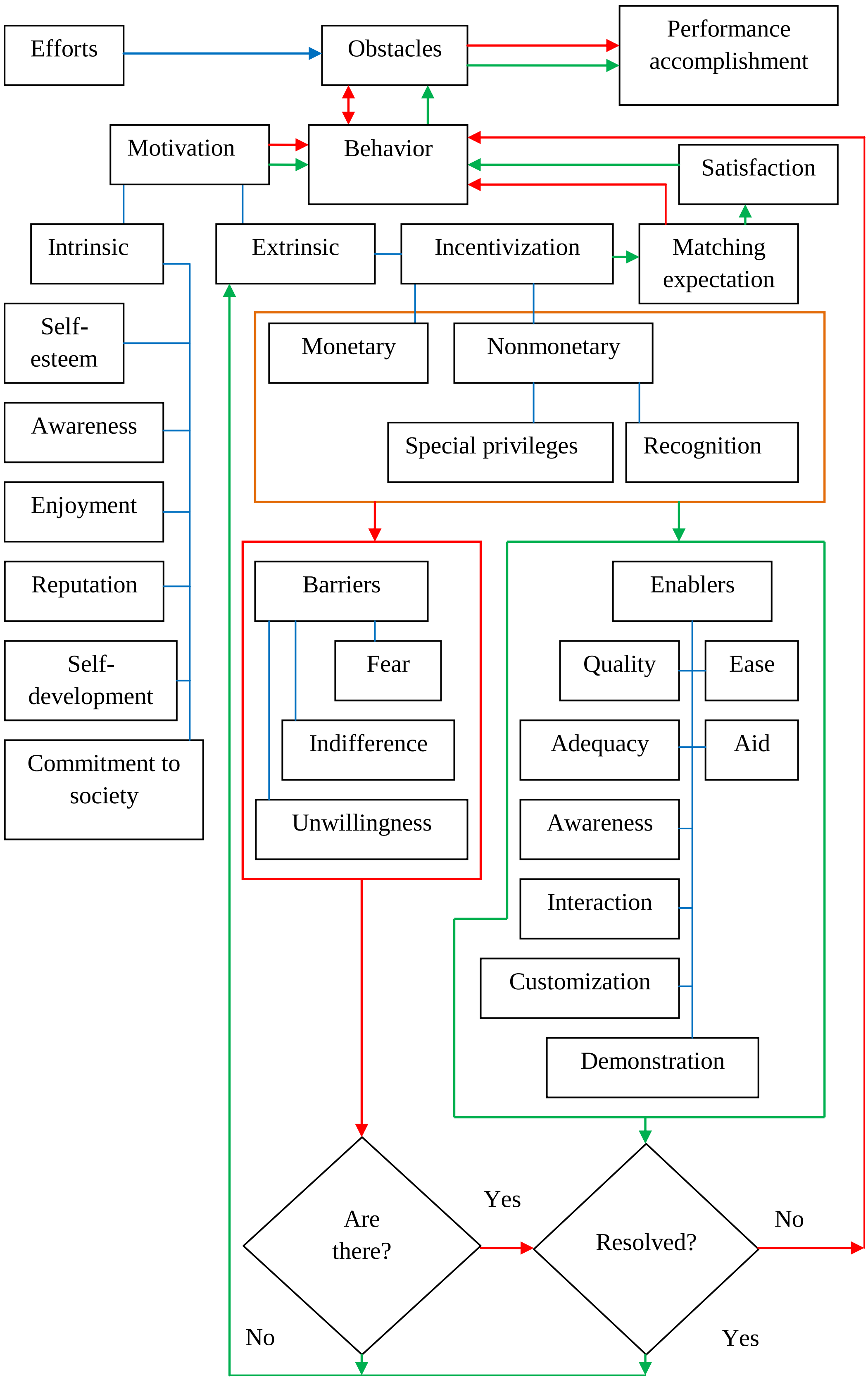

Fig. 6.6. Modified construct of incentive theory of motivation in a subsidized monopoly market

6.2.2.3.1.2. Unwillingness

Irrespective of the external motivation, consumers’ unwillingness to change their attitude depends on the necessary interaction required between the implementer and the consumer, for which they are not prepared.

Some consumers may also feel that the external controls proposed by the IBDRP will disturb their freedom. Many times, consumers may be worried about the data security related issues when allowing the external control of their load over the Internet. As hackers can relate the occupancy of the house based on the control strategies, the information can be misused to identify whether people are at home or not.

6.2.2.3.1.3. Indifference

As the product is already subsidized, some people may find the expected incentives also to be negligible. This is one of the reasons for the indifference of the consumers toward the program.

By incorporating different aspects of ITM, some enablers could overcome the barriers, which are listed in Table 6.6. The information collected from different stages, such as document analysis, semi-structured interviews, and theoretical coding, is clubbed together to consolidate the results obtained from objective 1, which are presented in the following section.

Table 6.6. Enablers and their description

Enabler	Description
Ease	Any procedure related to the IBDRP should be straightforward so that people can follow it easily.
Quality	By ensuring the quality of service, consumers' fear related to the risks of maintenance and operation can be overcome.
Aid	Aid in the form of financial support for financially weak people for procuring/ installation of control devices.
Adequacy	The incentives provided should be adequate to compensate the compromise done by the individuals.
Awareness	By giving proper awareness, a lot of people can be attracted.
Customization	IBDRP should be tailored to meet the targeted population.
Interaction	Continuous interaction between implementer and participant by using most modern technologies will narrow down the distance between two parties.
Demonstration	Demonstration of the results of a pilot study will wipe out suspicion among the people.

6.2.3. Combined results of objective 1

A detailed relationship diagram was prepared including the selective codes of both document analysis and semi-structured interviews, which is shown in Fig. 6.7. The colored codes are derived from the semi-structured interviews and are clubbed into the selective coding of document analysis. With the combined results, the implementation framework is formulated, which is the expected outcome of objective 1.

A lot of country-specific suggestions gathered from semi-structural interviews contributed to the preparation of the implementation framework. The framework addressed most of the concerns raised as part of the theoretical premise. To improve the quality and reliability, the existing electrical infrastructure required to be updated to enhance the utilization of GCC grid.

Additionally, an RE integrated IBDR program would be more beneficial to Kuwait than to the traditional ones. While updating the building codes, proper importance has to be given for adding more automation in the newly constructed buildings. By providing IHD for displaying power consumption instantaneously, consumer's awareness can be increased, which was one of the areas theoretical coding was focused on. A smartphone-based communication system will be helpful for an effective interaction with consumers.

Proper financial aid should be provided to economically weak consumers, and it should also be ensured that the risk related to hidden cost would not be there in any of the programs. The adequacy of incentives is another area to be concentrated where the MIs can be calculated dynamically by introducing production and implementation based model. The incentives should vary depending on the floor and orientation of the building where consumers stay. Feasibilities of introducing NMIs, based on CPs, can also be considered to attract consumers who are not influenced by financial benefits. It should also be ensured that the methods adopted for tailoring the programs are adequate enough to address possible customization needs raised by consumers. While considering the change in the weather conditions, the calculation of CBL cannot be done instantly in Kuwait. Two years' historical data would be required for establishing an appropriate CBL. By creating an early adapter group, a pilot study of the IBDR programs can be demonstrated in Kuwait for the easy understanding of various consumers.

The abovementioned results give a clear direction to the decision makers for implementing IBDR programs in Kuwait. Most of these codes are explained in detail as part of the document analysis, and semi-structured interview analysis can be referred to for more clarification, if needed.

However, testing the acceptance of IBDR programs by the residential consumers, which is the second research objective of this study, cannot be carried out with the developed implementation framework in the present way. Accordingly, to carry out the second research objective, three programs named RCSL, SVP and QBP with two different pricing methods are suggested to be implemented in KRS, which were derived as the result of objective 1. The details of these programs are given in the next section. The acceptance of these programs in the KRS is judged with the help of the second objective of the research study.

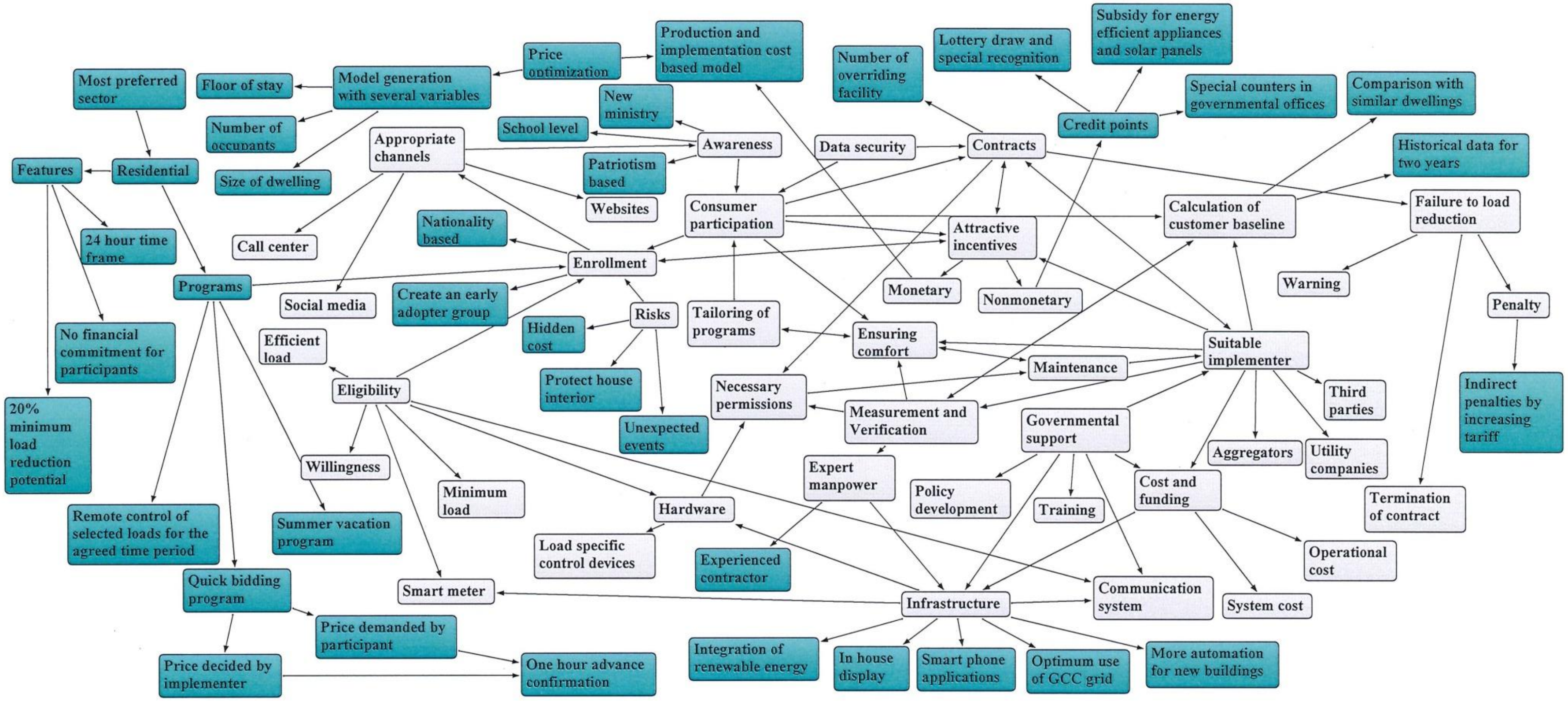

Fig. 6.7. Implementation framework

6.2.4. Formulation of new programs for Kuwait

To check the acceptance of IBDR programs among residential consumers, three new IBDR programs were suggested to meet various load curtailment objectives for the residential sector: pre-planned, long-term, and quick response. While formulating these programs, several important criteria were considered, which were emerged from the document analysis and experts' interview, such as the type of dwelling, occupancy pattern, peak power demand, and possible incentive schemes. The details of the suggested programs are given sequentially.

6.2.4.1. Remote controlling of selected loads in the agreed time period

This program targets consumers whose occupancy pattern changes in the different hours of the day. A family in which both husband and wife leave home to work while children go to school may find this program fascinating. In such cases, curtailing the load for getting some rewards will be interesting as it will not affect their comfort at all. Similarly, employees working in shift duties, people who are not staying with their families, individuals having a large house area in which their activities are limited to a certain portion of their house, etc., are other targetted consumers. RCSL is a DLC-based program in which power to the selected load of the enrolled customers will be disconnected during the approved time period. Six different time frames were proposed for implementing RCSL: early morning hours (04:00 to 06:00 hours), morning hours (06:00 to 8:00 hours), office hours (8:00 to 13:00 hours), peak hours (13:00 to 17:00 hours), evening hours (17:00 to 22:00 hours), and night hours (22:00 to 04:00 hours). The abovementioned timings were developed to match the load and different occupancy patterns of Kuwait on a peak power-consuming day, i.e., 30 August 2015 (Fig. 6.8). According to the experts, all the time frames have a high potential for electricity reduction as the residential community is highly diversified in Kuwait. Since many of the consumers will not be able to identify their load reducing potential, implementers have to extend their service in finding out the curtailable load in their facility. After discussing with consumers, some loads of less importance, matching with their time of occupancy/preference, need to be identified. Upon agreeing to the terms and conditions of the implementer, consumers have to allow implementers to install some devices for remotely controlling their appliances for the agreed time period. Once the RCSL program is put into practice, the power supply to the selected loads will be disconnected remotely, and the consumers will not have any control over their appliances. However, depending on the contract, some overriding facility will be given to consumers for handling emergency situations. With the help of the overriding facility, consumers can operate selected appliances temporarily. Based on the time frame and the curtailed load, consumers will be rewarded as per the contractual agreement.

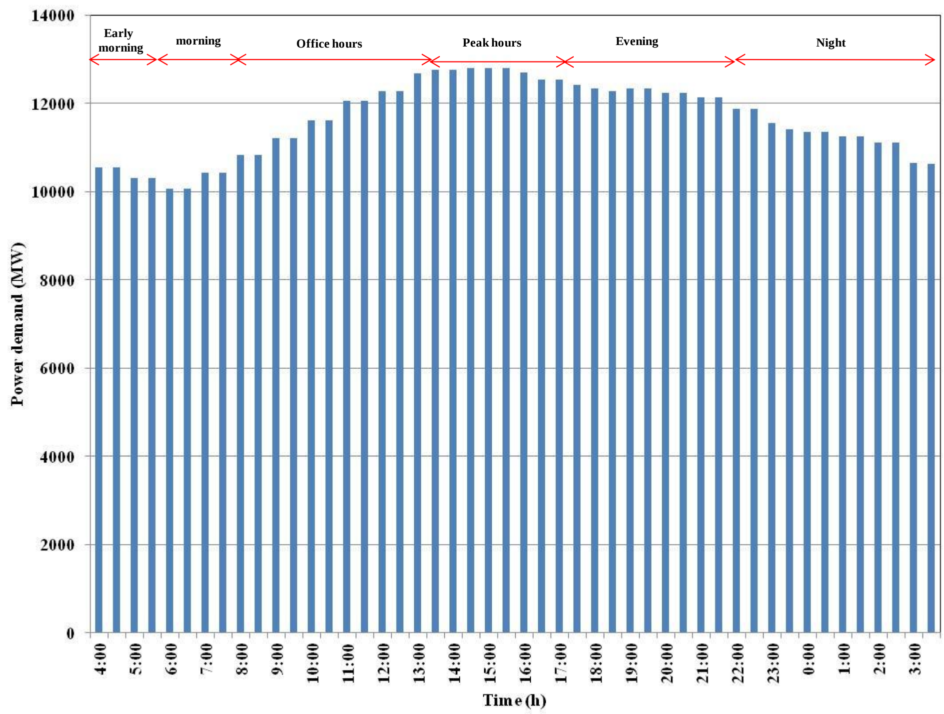

Fig. 6.8. Hourly peak power demand in Kuwait on a summer day [388]

6.2.4.2. Summer vacation program

The majority of nationals and expatriates travel during the summer period, which spans from May to September. The closure of schools for children and the unsuitability of outing due to the extreme weather conditions open the door for both nationals and expatriates to travel out of the country for a lengthy duration. Irrespective of these above facts, electricity demand for the summer period is the highest every year (Fig. 2.4). Therefore, programs such as SVP has a high significance. SVP requests consumers to enroll themselves in this program before they leave the country for a vacation. In return, different incentives are offered. In SVP, consumers have to reduce their load themselves without the influence of utility companies. In buildings where home automation systems are available, the control of the loads can be done remotely as well. However, this is not mandatory for the program as it involves additional cost.

6.2.4.3. Quick bidding program

According to the latest statistics, globally, Kuwait holds the 46th position in the percentage of residents using the Internet. According to this report, 78.4% of Kuwait’s population uses the Internet [237]. From this high Internet literacy rate, the influence of information technology on daily life can be assessed. 97% of the land area is covered with 4G LTE network, and at least one smartphone is found in 99.7% of the households [389]. Due to the affordability and wide coverage of Internet, consumers are “online” most of the time. QBP is an Internet supported DBBB-based program in which consumers are encouraged to negotiate their load reduction capability with the service provider for financial benefits, which is feasible to both implementers and participants. According to this program, utility providers announce their targetted load reduction for a selected period of a day and invite bids from consumers to reduce their consumption. Once the deal is finalized between both parties, it is the sole responsibility of the consumer to reduce the promised electricity load for the agreed time period. There are two variations of the program for calculating incentives: price decided by the implementer and price demanded by the consumer.

6.2.4.3.1. Price decided by the implementer

Under this scheme, the implementer decides the incentive that has to be given to the consumers. Based on the offered price, consumers can accept the offer or decline it. For example, utility companies like to avoid running a new generator unit during peak hours and look for a reduction of a specific quantity of load from consumers also. Accordingly, utility companies can announce the targetted load reduction on their website or mobile application and invite bids from consumers. In response to this, consumers are expected to submit their capability on load reduction. Depending on the number of interested consumers and the accumulated load reduction potential, the utility companies can announce a rate on their website or mobile application. Consumers can accept or decline the offer at this stage. It is highly expected that more the bidders and their load reduction capability, the lesser the incentives offered by the implementer and vice versa.

6.2.4.3.2. Price demanded by the consumer

Under this scheme, the load forecasting and announcing of the load reduction target will remain the same as in the previous case. The changes will be in the bidding process only. Here, bidders demand their expected price for load reduction, similar to a stock market. Among many offers, the implementer has the freedom to select the lowest quoted bids and make an agreement with the bidder. At the same time, if the bids are higher than the budgeted rate, utility companies can drop the load reduction plan as well. In both the cases, utility companies should inform the selected bidders well in advance so that consumers can take necessary measures to curtail the promised load.

6.2.4.4. Incentive schemes

As a reward to consumers for curtailing the load, both MI and NMI are offered for RCSL and SVP programs. As the QBP is dealing with cash only, no NMIs are offered.

6.2.4.4.1. Monetary incentive

In MI, consumers are offered a CRF for their load reduction. Two pricing schemes are provided for RCSL for peak power and nonpeak power periods. For SVP, a flat rate is offered for the complete vacation period. For QBP, only CRF is offered. However, it will change based on the bidding scheme.

6.2.4.4.2. Nonmonetary incentive

Under NMI, once participants opt for this scheme, they will get a membership in an elite club. Based on the time and amount of power reduction, points will be credited to their account. The more they reduce their loads, the more the chances of getting points. There will also be extra points for reducing consumption during the peak hours. These points can be redeemed for any of the following purposes: SSC, LDSR, and SDASP, which were detailed in the previous sections.

6.2.4.5. Common framework for all three programs

Even though the programs are different in several aspects, a lot of prerequisites and operational factors are common in all three of them. A network diagram was prepared with the help of ATLAS.ti for easy understanding and interpretation (Fig. 6.9). This diagram was prepared by concentrating on four major common areas: implementer, requirement, enrolling of consumers, and monitoring.

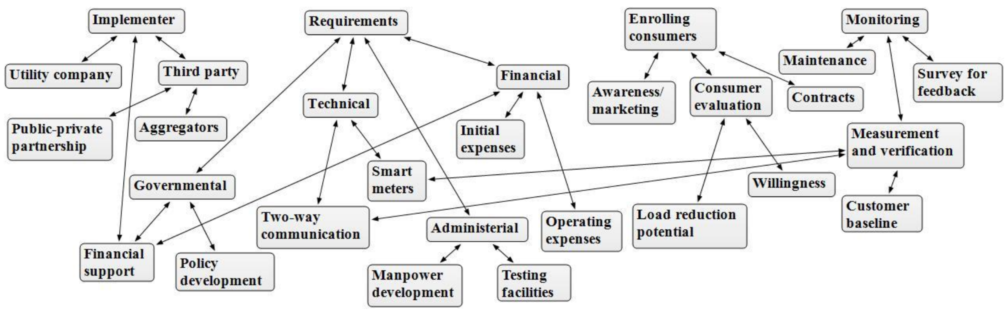

Fig. 6.9. Common framework for all proposed programs

All of the suggested programs can be implemented either by the existing utility provider or through a third party. Third parties can be introduced through a public-private partnership also. Aggregators can also be involved in the execution of these programs to limit the direct involvement of consumers. The governmental support in the areas of policy development and funding is also expected for the implementation of the programs. Minimum identified technical requirements include SM and TWC. Additionally, all essential components, such as control devices, need to be provided. These programs are developed by expecting no financial commitment from the consumers and the initial and operational expenses should be met by either the implementer or the government. The administerial requirement for the suggested programs was grouped into two major categories: manpower development and testing facilities.

With the help of proper awareness and marketing strategies, consumers can be enrolled in the programs. However, the capacity evaluation of the consumers should be carried out before launching any contract between the implementer and the consumer. The performance of the implemented programs needs to be monitored continuously, and proper PM and CM activities should be carried out to avoid a sudden breakdown. Monitoring should also focus on SM, TWC, and CBL. By conducting frequent surveys, consumers' feedback can be collected, which can be used for improving the programs.

The abovementioned parameters are commonly applied to all of the three programs, while each program has some specific requirement, which is detailed in the subsequent sections.

6.2.4.6. Special requirements of different programs

Apart from the abovementioned standard parameters in the framework, each program has some unique features, which have to be taken care of. The role of all of these codes, namely, TCLs, on/off loads (OOL), PTS, and Internet-based communication systems (IBCS), are detailed in the subsequent sections.

6.2.4.6.1. Special requirements of the remote controlling of selected load programs

As the consumer's load is remotely controlled in this program, the selection and installation of load-specific control devices play a significant role. For easy classification, the electrical loads are categorized into two groups: TCL and OOL. Loads, such as AC and WHs come under the TCL, and the complete closure of such loads is considered only when the AC unit or WH is not compatible with the control devices. In normal conditions, to control the load of these units, appropriate variations in the temperature set point of the

PTS are made. Almost all other loads such as lights, motors, fans, etc., come under OOL, as their operation is controlled by connecting/disconnecting electrical power to these units. For both cases, proper communication interface needs to be introduced to achieve the desired results.

6.2.4.6.2. Special requirements of summer vacation program

The consumers enrolled in the SVP keep their load shut for a long duration compared to those who enrolled in other programs. On the top of it, this program asks consumers to control their load according to their preferences. A total closure of AC during the summer season is not advisable as it may affect the interior of the dwelling. This can be taken care of by offsetting the setting of PTS. In one of the energy conservation campaigns named "Tarsheed," the MEW advised residents to raise their thermostat settings before traveling. However, depending on the duration of the travel, the temperature buildup in the house may reach to a situation when a lot of time will be required to make the entire home reach its comfort zone. With the help of PTS, proper precooling of the house can be achieved. PTS with Internet connectivity can be accessed from remote locations, while the stand-alone units can be programmed as per the travel plan.

6.2.4.6.3. Special requirements of quick bidding program

The IBCS is not mandatory to RCSL and SVP, while it is one of the primary needs for QBP. Since the entire program targets to reduce a certain amount of load, based on prediction, which depends upon many factors such as weather conditions, maintenance issues, load instability, etc., utility companies may not be able to announce the targetted load reduction at a fixed time on a daily basis. With the help of Internet-based applications, the message can be spread to the interested customers quickly. By using this method, consumers can also place their bids easily. The information on the bid selection can also be communicated by the utility companies through Internet-based applications. Furthermore, utility companies may have to keep a database of consumers who regularly participate in their programs for contacting them through some alternate way of communication, such as the short message system, to ensure that the information about the event reaches them on time, in case of Internet failure.

The first research objective of this study was achieved by developing an implementation framework for introducing IBDR programs in the electrical distribution market of Kuwait. During the process, a detailed document analysis was carried out to identify different components, which should be included in the framework, and were validated and further expanded by conducting semi-structured interviews of experts in the KES. To check the acceptance of such programs among the residential consumers, three most suitable programs were suggested. These programs were developed by focusing on the different aspects learned during the process of document analysis and experts' interviews. The proposed programs were presented to consumers through a survey to get their feedback on the acceptance of such programs. The results of the analysis carried out on the information collected from the survey are presented in the next section.

6.3. Results of survey analysis (objective 2)

Introducing any new product to a new market needs proper preparation. The critical step is ensuring the acceptance of such products in the new market. Many commercial companies have a dedicated team to assess the market potential so that products can be tailored to match the expectation of the consumers.

As a result of the first research objective, a clear framework was developed to introduce IBDR programs by considering various essential aspects of KES. Even though the framework was prepared based on the latest literature on the subject and validated/extended by incorporating comments from experts, the user's response to such programs could not be explored.

In the second objective, the acceptance of IBDR programs by the consumers of KRS was measured with the help of a survey-based data analysis.

6.3.1. The questionnaire

As mentioned in the methodology, a questionnaire was prepared to collect the data from consumers. Apart from the general information and feedback, the questionnaire contained precise questions to identify the consumers' willingness to participate in different programs for various time frames under two separate incentive schemes.

From the interview results, it was learned that both MI and NMIs could be used to motivate the consumers of KRS. The MI was designed as CRF schemes with three different rates. As far as RCSL was concerned, any reduction in peak hours was rewarded high (15 fils per kWh) compared to nonpeak hours (10 fils per kWh). For SVP, the CRF was kept flat (10 fils per kWh) for the entire time period. All the offered rates were restricted to a maximum of 25% of the production cost of electricity. The NMIs were designed based on CPs, which will be added to the consumers' account in line with their power reduction. Such collected points can be redeemed for different purposes such as SSC, SDASP, and LDSR. Both the MI and NMIs are designed hypothetically to check the interest of consumers.

To assess the interest of consumers at various times of the day, RCSL and QBP are divided into six time frames, which are different activity hours of the day. At the same time, the time frame for SVP was prepared to cover different percentages of the total vacation time.

6.3.2. Pilot test

To improve the questions, formats, and scales in the questionnaire, a pilot testing was carried out [219]. The questionnaire was pretested with 25 professionals, including energy experts, statisticians, and academicians. The feedback was found to be very helpful in making the questionnaire more concise and specific for the desired objective. The pilot testing not only helped in rectifying some of the weaknesses of the questionnaire but also helped in establishing the content validity of the questionnaire. The revised final questionnaire is given in Appendix A16.

6.3.3. Data collection

As the minimum required responses were 400, the questionnaire was circulated among more than thousand people to get the feedback. BY the end of a month-long campaign, the researcher managed to get a total of 914 responses, out of which 519 responses were found to be complete. Among the completed responses, 155 were from Kuwaiti nationals. This is a genuine representation of the Kuwaiti population, which constitutes 30% of the total population of the country. Country-wise participation of expatriates was not included in this study.

6.3.4. Exploratory data analysis

As the first step, all data were fed into the SPSS software based on their type. Details of the different types of questions and their numerical representation are listed in Table 6.7 and the details of coding are given in Appendix A17.

After feeding the data into SPSS, an exploratory data analysis was carried out. The fundamental aim of conducting such an analysis was to identify the outliers, which can influence the proposed analysis [390]. Bivariate linear regression was carried out for each time frame (for different programs and incentive schemes) by keeping user willingness as the independent variable and load reduction as the dependent variable. All of the cases above the standardized residual value of 3 and below -3 were considered as outliers and were taken out from the data [239]. After the cleanup of the data, a total of 448 responses were selected for further analysis. These data also represented the Kuwaiti and non-Kuwaiti ratio of 30% and 70%.

Table 6.7. Coding of responses in SPSS

Section	Question Nos.	Type	Scale	Number of variables
General information	1, 7,12,13	Dichotomous	1 and 2	4
	2,4,5,8	Multiple choice	1 to 6	4
	3	Open-ended (text)	1 to 8	1
	6,9,10,11	Open-ended (numerical)	As it is	4
PR-1 RCSL	14,15,16,17	Likert scale	1 to 5	24
PR-2 SVP	19,20,21,22			12
	18	Multiple choice	1 to 10	1
PR-3 QBP	23,24,25,26	Likert scale	1 to 5	24
General feedback	27,29	Likert scale	1 to 5	7
	28	Dichotomous	1 and 2	1
	30	Open-ended (text)	Not scaled	0

Coding in SPSS is used to convert responses into a numerical format. In the questionnaire, both open-ended and closed questions were used to gather response from consumers [239]. Three types of closed questions were used in this survey, which gave responses in the form of dichotomous, multiple choices, and Likert scale. Dichotomous type questions are easy to convert, which has two option, either 1 or 2. Examples of such questions were nationality, payer of electricity bill, and various “yes” or “no” type questions related to awareness, ability, and opinion. Multiple choice questions allowed consumers to select the best option from the provided list of choices. Age groups, the location of the house, type of building, income range, and the number of weeks consumers stay out of Kuwait during the summer season were the related questions. The given choices were varied based on the nature of questions. The coding for these responses was directly linked to the choices as it appeared in the questionnaire. The last type of closed-end questions was supported by Likert scale responses. A five-scale Likert scale was used to get feedback on consumer’s interest, possible load reduction, and preferences. “One” represented the most negative response, while “five” denoted the most positive response.

Both text-based and numerical-based open-ended questions were included in the questionnaire. The text data received from consumer’s profession were grouped into 8 categories and were given the coding from 1 to 8. Responses received for questions where numerical results were expected, such as the number of rooms in the house and details on the number of family members were recorded as it is. The response to the last question of the questionnaire was gathered as it was and was not converted to numerical codes.

6.3.5. Validity and reliability

The validity of the data is crucial in the survey method of data collection. This represents whether an inference can be drawn from the collected data or not [219]. Face validity, a measure of an indicator “makes sense” as a means to judge the questions by the scientific community [387], was carried out during the pilot testing stage itself. Content validity, a measure representing all aspects of the conceptual definition of a construct, was also ensured with the help of experts who were part of the pilot study [218]. A content validity ratio was calculated based on the suggestions given by the experts, who were part of the pilot study. The content validity ratio was found to be in the range of 0.622 to 0.99, which can be accepted. Based on this, all of the questions were found to be “essential”, and the content validity was established [391].

Reliability refers to the consistency or the stability of test scores. The reliability was tested using Cronbach’s alpha method [392]. This test was carried out in SPSS as a scale reliability test, and the overall Cronbach’s alpha was found to be 0.893, which can be interpreted as “highly reliable” [220].

6.3.6. Demographic statistics

During the data collection process, extreme care was taken to keep a balance in the demographic characteristics of the population. From the results shown in Fig. 6.10, it is evident that the demographics of the collected data truly represent different categories of the population. For example, nationality data accounts for a ratio of 30:70, which is the actual ratio of Kuwaiti and non-Kuwaiti's population.

Similarly, it can be observed that the collected data represents all the leading professions in Kuwait, age groups, houses in different governorates, type of various dwellings, and the total family income.

As the further analyses such as hypothesis test, Mann-Whitney U test, and McNemar Chi-Square tests dealt with two categories of consumer willingness derived from questions 14, 6, 19, 21, 23, and 25, the responses from these questions were clubbed together to formulate two groups, namely, "interested" and "not interested". The responses "not interested" and "not at all interested" were clubbed together to form a single group "not interested". Similarly, "interested" and "highly interested" were clubbed together to form another group, "interested" [387]. The responses of "not sure" were excluded from the analysis, as it represented a neutral view, neither positive nor negative.

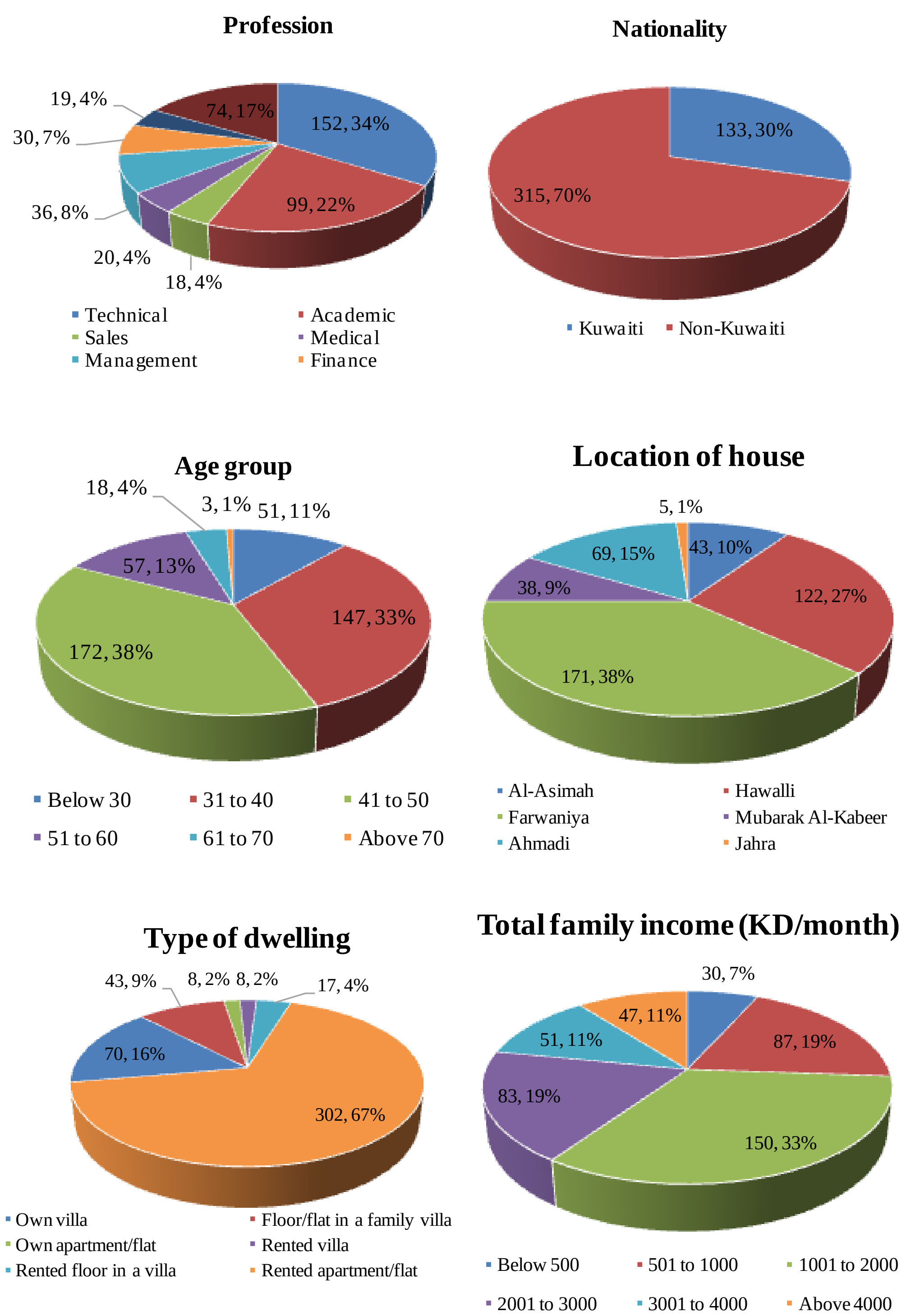

Fig. 6.10. Demographic statistics of the collected data

The collected data were used for different analyses to assess the responses of consumers to IBDR programs. A hypothesis test was carried out to check the association between consumers' interest to partake in the program and the expected load reduction. A detailed description of the hypothesis test is given subsequently.

6.3.7. Hypothesis test

A Chi-Square test is a statistical test frequently used in social science used to check the hypothesis. In this nonparametric test, no assumption needs to be made about the form of the original population distribution from where the samples are extracted. The Chi-Square test is based on a null hypothesis, which is the guess that two observed populations have no relationship, and compares expected-outcome frequencies with observed frequencies to find the distribution of variables if the two are unrelated [233]. By using the cross tabulation in SPSS, Chi-Square test was carried out to check the following hypothesis.

Null Hypothesis, H_1*: There is no association between incentivization and load reduction*

To test the above hypothesis, Chi-Square tests were conducted individually for different time frames using SPSS. Willingness to participate in two scales (interested and not interested) was taken as row and agreed load reduction was taken in a five scale (0% reduction, reduce 1 to 25%, reduce 26 to 50%, reduce 51 to 75%, and reduce 76 to 100%) in the column for the cross-tabulation analysis in SPSS. The test was carried out for all three programs under different incentive schemes in every time frame.

Pearson Chi-Square values and Asymptotic Significance (2-sided) values for each case are tabulated in Table 6.8. The values for each case were found to be consistent with all time frames. The high Chi-Square value indicated the strength of the association between two variables showing the strong association between willingness to participate and agreed load reduction. As the Asymptotic Significance (2-sided) values for each case were below the 95% confidence level ($p<0.05$), the null hypothesis was rejected, and the alternative hypothesis was accepted. From the accepted alternate hypothesis, it can be concluded that there is a significant association between willingness to participate in the program and load reduction among the consumers. This shows that power reduction could be achieved by offering incentives to the consumers.

Table 6.8. Results of Chi-Square test

Column: Agreed load reduction. Row: Willingness to participate				
Program	**Incentive**	**Time frame (hours)**	**Pearson Chi-Square**	**Asymp. Sig. (2-sided)**
RCSL	CRF	04:00 to 06:00	168.85	.000
		06:00 to 08:00	181.34	.000
		08:00 to 13:00	164.12	.000
		13:00 to 17:00	154.23	.000
		17:00 to 22:00	167.48	.000
		22:00 to 04:00	173.97	.000
	CP	04:00 to 06:00	153.16	.000
		06:00 to 08:00	149.93	.000
		08:00 to 13:00	180.31	.000
		13:00 to 17:00	159.22	.000
		17:00 to 22:00	145.54	.000
		22:00 to 04:00	151.81	.000
SVP	CRF	Up to 50% of vacation	201.31	.000
		51 to 90% of vacation	213.15	.000
		Above 91% of vacation	199.22	.000
	CP	Up to 50% of vacation	248.16	.000
		51 to 90% of vacation	263.32	.000
		Above 91% of vacation	221.63	.000
QBP	PDI	04:00 to 06:00	171.94	.000
		06:00 to 08:00	161.23	.000
		08:00 to 13:00	198.62	.000
		13:00 to 17:00	188.44	.000
		17:00 to 22:00	134.75	.000
		22:00 to 04:00	200.00	.000
	PDC	04:00 to 06:00	185.69	.000
		06:00 to 08:00	181.92	.000
		08:00 to 13:00	214.25	.000
		13:00 to 17:00	219.78	.000
		17:00 to 22:00	191.32	.000
		22:00 to 04:00	203.73	.000

From the Chi-Square test, the effect of incentivization on the load reduction was established. To quantify the interest of consumers favoring and not favoring the programs (interested and not interested, respectively), a Mann-Whitney U test was performed. The results are given subsequently.

6.3.8. Ranking of the distribution of responses

Mann-Whitney U test is used to rate two groups in the same population based on their ranking [220]. In this study, this test was used to identify the prominent group among consumers showing “interested” and “not interested” responses to the IBDR program. Accordingly, the following hypothesis was formulated.

Null hypothesis, H_2*: The responses of “not interested” and “interested” are identical*.

For carrying out the abovementioned test, two groups of independent variables were selected, namely, load reduction and willingness to participate. During the analysis in SPSS, dependent variables (load reduction) were fed as the testing variable and independent variables (interested/not interested) were fed as the grouping variable. These dependent variables were tested with independent variables of load reduction, which were in the Likert scale (1 to 5). The test was performed for all three programs under various incentive schemes for different time frames.

The results of Mann-Whitney test are summarised in Table 6.9. From the results, it is clear that the load reduction scores are not equal for two groups. As an example, for the time frame of 04:00 to 06:00 (program RCSL and incentive scheme CRF), the mean rank of “interested” group is 219.7, which is higher than the mean rank of “not interested”, which is 109.6 only. The asymptotic significance (2-sided) values for a confidence level of 95% was found to be zero ($p<0.05$).

Table 6.9. Results of Mann-Whitney test

Program	Incentive	Time frame (hours)	Groups	Mean rank	Mann Whitney test Z	Asymp. Sig. (2-sided)
Test Var: Agreed load reduction. Grouping Var: Willingness (Not interested/Interested)						
RCSL	CRF	04:00 to 06:00	Not Interested	109.6	-11.104	.000
			Interested	219.7		
		06:00 to 08:00	Not Interested	112.5	-11.061	.000
			Interested	222.0		
		08:00 to 13:00	Not Interested	88.7	-10.211	.000
			Interested	202.7		
		13:00 to 17:00	Not Interested	97.5	-11.079	.000
			Interested	205.2		
		17:00 to 22:00	Not Interested	104.6	-11.518	.000
			Interested	215.1		
		22:00 to 04:00	Not Interested	107.1	-11.690	.000
			Interested	224.0		
	CP	04:00 to 06:00	Not Interested	117.2	-11.235	.000
			Interested	229.7		
		06:00 to 08:00	Not Interested	119.8	-11.123	.000
			Interested	233.1		
		08:00 to 13:00	Not Interested	96.5	-11.408	.000
			Interested	215.1		
		13:00 to 17:00	Not Interested	104.6	-11.425	.000
			Interested	216.6		
		17:00 to 22:00	Not Interested	115.1	-10.732	.000
			Interested	220.4		
		22:00 to 04:00	Not Interested	114.4	-10.915	.000
			Interested	224.2		
SVP	CRF	Up to 50% of vacation	Not Interested	79.8	-11.297	.000
			Interested	217.1		
		51 to 90% of vacation	Not Interested	78.5	-12.309	.000
			Interested	207.2		
		Above 91% of vacation	Not Interested	85.0	-12.327	.000
			Interested	206.7		
	CP	Up to 50% of vacation	Not Interested	67.4	-12.704	.000
			Interested	209.7		
		51 to 90% of vacation	Not Interested	75.5	-13.326	.000
			Interested	214.6		
		Above 91% of vacation	Not Interested	84.4	-12.766	.000
			Interested	212.0		
QBP	PDP	04:00 to 06:00	Not Interested	106.0	-11.502	.000
			Interested	218.8		
		06:00 to 08:00	Not Interested	108.2	-10.966	.000
			Interested	215.1		
		08:00 to 13:00	Not Interested	80.4	-11.517	.000
			Interested	200.3		
		13:00 to 17:00	Not Interested	97.6	-11.506	.000
			Interested	211.0		
		17:00 to 22:00	Not Interested	111.0	-10.237	.000
			Interested	211.0		
		22:00 to 04:00	Not Interested	100.7	-12.279	.000
			Interested	221.5		
	PDC	04:00 to 06:00	Not Interested	107.7	-11.736	.000
			Interested	223.3		
		06:00 to 08:00	Not Interested	107.7	-11.736	.000
			Interested	223.3		
		08:00 to 13:00	Not Interested	108.4	-11.510	.000
			Interested	221.9		
		13:00 to 17:00	Not Interested	84.5	-12.285	.000
			Interested	210.1		
		17:00 to 22:00	Not Interested	96.1	-12.823	.000
			Interested	223.1		
		22:00 to 04:00	Not Interested	104.0	-12.251	.000
			Interested	223.1		

Since there was a significant difference between two groups regarding their mean rank and the asymptotic significance (2-sided) values were always zero, the null hypothesis was rejected, and the alternate hypothesis was accepted. From these results, it can be further claimed that irrespective of the subsidized pricing, consumers can be motivated to join for the EC programs.

From the Chi-Square test and Mann-Whitney test, it was concluded that the majority of the consumers were interested in the proposed IBDR programs, and load reduction could be achieved by giving appropriate incentives. However, it was not clear whether their interest will change with the change in the incentive schemes. The following test was intended to clarify this uncertainty.

6.3.9. Change in the consumers' interest in the monetary and nonmonetary incentives

To check the impact of the change in incentive schemes on consumers' interest, a McNemar Chi-Square test was performed. McNemar test is used to check the association between dichotomous data of two sets of samples when the collected data involve a "before and after" situation. The test is planned in such a way that the subjects were seperated into two sets based on their favorable and unfavorable views on any system. After some management, the same number of subjects were requested to share their opinions about the given system, to know whether they favor it or not [218]. In this present case, same customers gave their preferences for different incentive schemes at one point in time.

In this occasion, for the analysis, the "before" situation was taken as the responses received for one incentive scheme and the "after" situation was taken as the responses received for another incentive scheme, under the same main program. As part of the preparation of data, responses were grouped into two based on willingness, namely, "not interested" and 'interested." As this test was intended to see the interest of consumers in different incentive schemes, CRF, and CPs, the analysis was carried out for programs RCSL and SVP only. QBP was excluded as the incentives in this program were based only on CRF. The null hypothesis, in this situation, was the two incentive schemes, CRF and CPs, which were equally preferred by the customers.

McNemar Chi-Square test was performed to test the following hypothesis.
Null hypothesis, H_3*: There is no association between consumers' willingness with a change in incentives.*

For performing McNemar Chi-Square test, consumer willingness related responses for the first incentive (CRF) was given as rows and willingness related responses for the second incentive (CP) was taken as columns in SPSS. Cross-tabulation for McNemar statistics was run for all different time frames for both RCSL and SVP. From the results, it can be concluded that there is no significant difference in the interest of consumers when the incentive scheme was changed. For example, in the case of RCSL for 04:00 to 06:00 hours time frame, only 17 consumers who had shown their interest in CRF were found to be not interested in CPs. Similarly, only 14 consumers who had shown their interest in CPs were found not to be interested in CRF. Probability value (p-value) was calculated via online calculator [393], by giving McNemar Chi-Square value as input with a degree of freedom of 1 and confidence level 0.05. From the results shown in Table 6.10, it can be noticed that for both programs, the p-value was always higher than the confidence level ($P>0.05$). Hence, the null hypothesis was accepted. According to the null hypothesis, there is no association between the change in the incentive scheme and the consumer's willingness.

While consolidating the results of hypothesis test, Mann-Whitney test, and McNemar test, it can be concluded that even in the subsidized market of Kuwait, consumers can be motivated to reduce their electricity consumption by offering MI or NMIs. The proposed NMI schemes were not implemented any of the markets but were included based on the suggestions of experts to attract consumers who may not show any interest in financial incentives. Hence, it was decided to check the consumers' feedback on their choices among the CRF and different uses of CPs. The next section details the results.

Table 6.10. Results of McNemar Chi-Square test

Program	Time frame (hours)	CRF	CP		McNemar Chi-Square	p-Value
			I *	NI **		
RCSL	04:00 to 06:00	I	105	17	0.13	0.72
		NI	14	147		
	06:00 to 08:00	I	89	19	0.78	0.38
		NI	13	154		
	08:00 to 13:00	I	177	25	3.18	0.070
		NI	13	82		
	13:00 to 17:00	I	120	17	0.30	0.58
		NI	13	113		
	17:00 to 22:00	I	101	16	0.14	0.71
		NI	13	134		
	22:00 to 04:00	I	111	16	0.12	0.73
		NI	17	138		
SVP	Up to 50% of vacation	I	218	15	2.23	0.14
		NI	7	66		
	51 to 90% of vacation	I	167	7	0.27	0.60
		NI	8	88		
	Above 91% of vacation	I	137	9	0.06	0.81
		NI	9	107		

*Interested ** Not interested

6.3.10. Most preferred incentive scheme

In the proposed incentive schemes, the MI scheme was limited to CRF only, while CPs can be redeemed for different NMIs, such as SSC, SDASP, and LDSR. A separate analysis was carried out to see the interest of consumers among various incentive schemes. This analysis was conducted based on the responses received to question No. 29, in which consumers' preference was gathered in a Likert scale format (1 for "not at all preferred", 2 for "Not preferred", 3 for "not sure", 4 for "preferred", and 5 for "highly preferred"). Through this question, 448 responses were gathered, which indicated the preference of participants among all the four incentive schemes, including both MI and NMIs. Counts of both "preferred" and "highly preferred" were clubbed together to show as "preferred", while "not preferred" and "not at all preferred" were clubbed together to "not preferred." Responses received on "not sure" were not included in both the cases. A frequency table was created to check the most preferred incentive scheme using the SPSS. The results are presented in Table 6.11 in chronological order.

Table 6.11. Frequency distribution of the most preferred incentive scheme

Incentive schemes	Total responses	Interested respondents	
		Number	Percentage
CRF	448	316	70.5
SDASP	448	288	64.3
SSC	448	270	60.3
LDSR	448	176	39.3

From the results, it can be confirmed that the most preferred incentive scheme was CRF. At the same time, consumer's preference for NMIs is also significant. Among the NMIs, most of the consumers preferred SDASP, followed by SSC. Compared to these options, preference for LDSR was found to be very low.

The three IBDR programs suggested are having different characteristics. RCSL and SVP are DLC based while QBP is a QBBB program. Another classification of the program is based on the time frame of these programs. Both RCSL and QBP are hourly plans, while SVP is a long-term plan. Even though the hypothesis test proved the acceptance of these programs among the consumers, it was not clear about consumers' preference among these programs. A dedicated question was included in the questionnaire to get feedback on this subject. The results are presented in the subsequent section.

6.3.11. Most preferred incentive-based demand response program

Similar to the question related to the most preferred incentives, a question was dedicated to finding the most preferred program also (Question No. 27). The choices given to consumers were different programs, and their preferences were recorded on a 5 point Likert scale as mentioned in the earlier section.

The collected data were fed to SPSS in a similar way. Frequency table was prepared as part of the analysis. From the results, it was concluded that the most preferred program was SVP, followed by RCSL and QBP. The details of frequency distribution are given in Table 6.12.

Table 6.12. Frequency distribution of most preferred incentive-based demand response program

Program	Total responses	Interested respondents	
		Number	Percentage
SVP	448	294	65.6
RCSL	448	230	51.3
QBP	448	164	36.6

As SVP was planned to be implemented during the vacation period of the participants, less comfort related issues were anticipated. This could be one of the reasons behind the high acceptance of this program. Additionally, control devices were not needed to be installed in the house as part of this program, which would reduce the maintenance related issues and frequent interactions between the implementer and the consumers.

6.4. Summary

In the first objective of this study, an effort was made to draw a big picture of the different factors that had to be taken care of while implementing IBDRP in any retail subsidized electricity market. From the developed framework, it was evident that the implementation of IBDRP is tough in markets where proper governmental policies are not available. Spreading of awareness amongst the residents should be a continuous process targeting all sectors and regions, irrespective of their demographical conditions. In addition to the creation of awareness, adequate infrastructure should be developed to suit diverse programs. The markets that did not meet the infrastructure requirement may consider upgrading their systems to smart grids by adding more RE and non-

RE based microgeneration units to get the complete benefit of the program. As the success of such programs without a proper motivation regarding incentives is doubtful, proper measures have to be taken for identifying the appropriate incentives. From the framework, the most prominent areas to be focused were identified, and the importance of these parameters was validated by gathering information from experts. After obtaining sufficient and suitable data from the experts' interviews and by mapping them with the selective coding generated as the result of document analysis, a proper implementation framework was developed, which was used for framing three different most appropriate IBDRPs for Kuwait's electricity market: RCSL, SVP, and QBP.

Based on the results of the analysis conducted on the information collected using the questionnaire, it can be inferred that the outcomes of objective 2 supported all the IBDR programs suggested by the results of objective 1 and can positively influence consumers for reducing their electricity consumption. Among the three suggested programs, SVP was preferred by majority of the consumers. Likewise, among the four incentive schemes, the most of the consumers preferred CRF as the best option. Consumers were not only attracted to MIs (CRF), but also interested in different NMIs. The change in the incentive scheme had no influence on the willingness to participate among the group of consumers who were "interested" in IBDR programs. An additional study is required to be done to identify the influencing factors for the consumers in the category of "not sure" and "not interested." By identifying these factors, proper motivation can be given to consumers in these selected groups for shifting their willingness to "interested", which can have a high impact on the success of IBDR programs in the country.

The findings of document analysis, semi-structured interviews, and consumer survey analysis emphasized the need for policies to support DR strategies. The next chapter focuses on the need for different policies to introduce IBDR strategies in the subsidized electricity market of Kuwait.

7. POLICY ASSESSMENT

7.1. Introduction

All the policies need to be regularly updated to include the latest changes in the socioeconomic developments [394]. The implementation of IBDR strategies in any new market needs to be supported by proper policies, and in recent times, many researchers are focusing on policy-related studies. By focusing on the results gathered in the study at different stages, the need for different policies is revealed, which is discussed in the next section.

7.2. Need of policy formulation

From the different analyses carried out in the study, it was learned that all IBDR implementations require good policy support. The importance of governmental support was one of the significant findings of document analysis. All the experts also agreed to it as there are no proper policies available in Kuwait to support IBDR implementation. From the behavior aspects of consumers, learned as part of theoretical coding, three barriers were identified, namely, fear, indifference, and unwillingness. To an extent, the lack of an effective IBDR policy is one of the reasons behind these barriers. The identified enablers also emphasized on the need of different policies. All of the above assumptions were made based on the findings from objective 1, which was mainly focused on the development of the implementation framework. The results of the survey analysis based on the direct responses received from the consumers, having good significance in this study, as it focused on the end users in the market where IBDR programs were proposed to be introduced. In addition to the need for an IBDR policy, the results of survey analysis focused on the need for policies in three more areas: policy for consumer-focused awareness, policy for giving incentives, and policy for power usage during summer vacations (Fig. 7.1), which were supported by the results of objective 1.

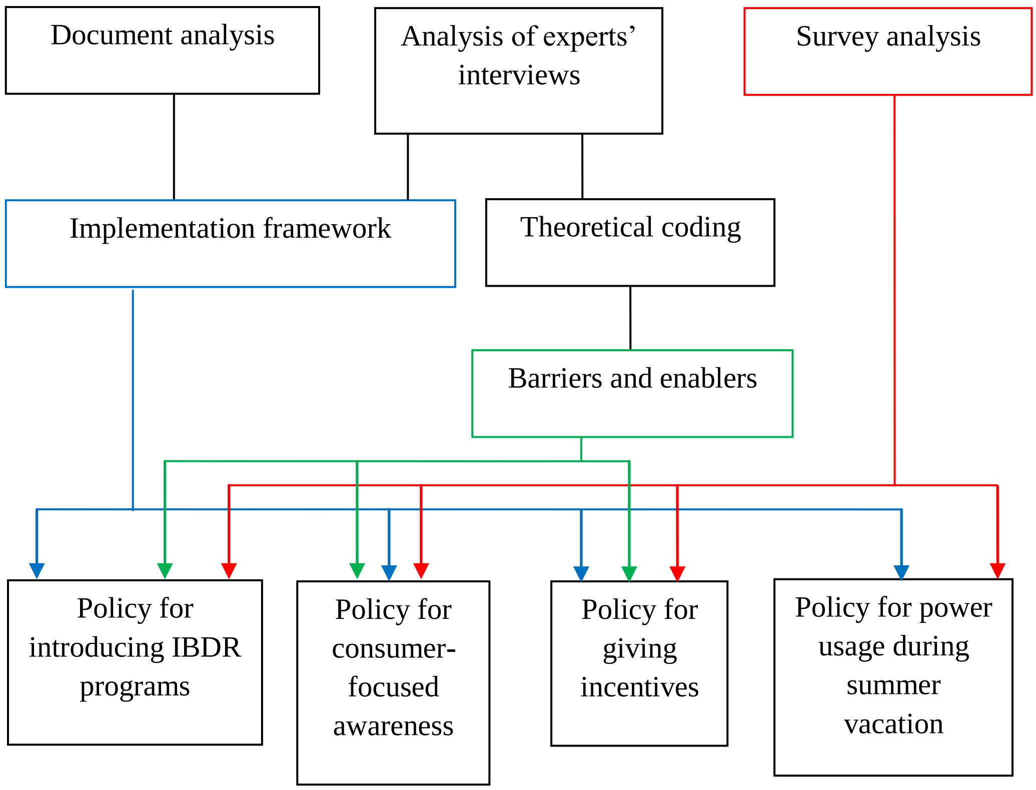

Fig. 7.1. Policy requirements

7.2.1. Policy for introducing incentive-based demand response programs

Irrespective of the subsidized pricing, consumers' interest toward the IBDR programs showed their level of interest toward controlling the energy wastage in the country. From the survey results, it was clear that by giving appropriate incentives, customers can be motivated to reduce their power consumption. However, according to experts, it needed proper policy support from the government's side. It is important that while developing the policies, attention should be given to many areas such as implementer, infrastructure, and cost and funding. In most of the markets, the implementation of all EC programs is carried out by the utility establishment only [305]. Depending on the government's strategy, different ways for introducing new agencies can be included in the newly developing policy. Some of the potential agencies that can be considered are aggregators, private companies, non-profit organizations, etc. Funding and profit sharing are other important aspects that have to be included in the policy. This aspect can be interconnected to the required upgrading of infrastructure to implement IBDR programs effectively.

As SMs are required to measure and record the power consumption, it can be considered as the minimum infrastructure required for the implementation [2,153,280]. This means that the policy should be adequate to ensure the installation of SMs in all dwellings.

7.2.2. Policy for consumer-focused awareness

While analyzing the survey data, the ranking of consumers based on “not interested” and “interested” categories, was carried out keeping “not sure” as neutral. From the results, it is clear that consumers in the “interested” category are more than those in “not interested” category. This leads to the need for formulating a special policy for finding consumers in the “not interested” category and exploring the reason behind their decision. This will open the door to addressing some unknown factors and remediation processes. Such policies can include consumers in “not sure” category also. For example, from Fig. 7.2, it can be noticed that for the time period of 8:00 to 13:00 hours, 233 consumers showed interest in cooperating with RCSL having CRF scheme. For the same period, 102 consumers expressed their unwillingness in the form of “not interested” and 103 consumers were “not sure” whether to participate or not. This scenario is similar to other programs also. It can be assumed that addressing the concerns of consumers in “not sure” category would be easy compared to addressing the concerns of consumers in “not interested” category. From the same figure, it can also be observed that in the case of SVP, consumers in “not sure” category are much lesser than RCSL and QBP. This is due to the simplicity of the SVP compared to other programs. By providing proper awareness and taking care of their concerns, authorities can remove different hindrances that restrict consumers from participating in various IBDR programs. By following a properly developed policy, most of the consumers in “not sure” category can be elevated easily, but gaining the willingness of consumers in “not interested” category may require more intensified study to make the proposed policy a rigid one.

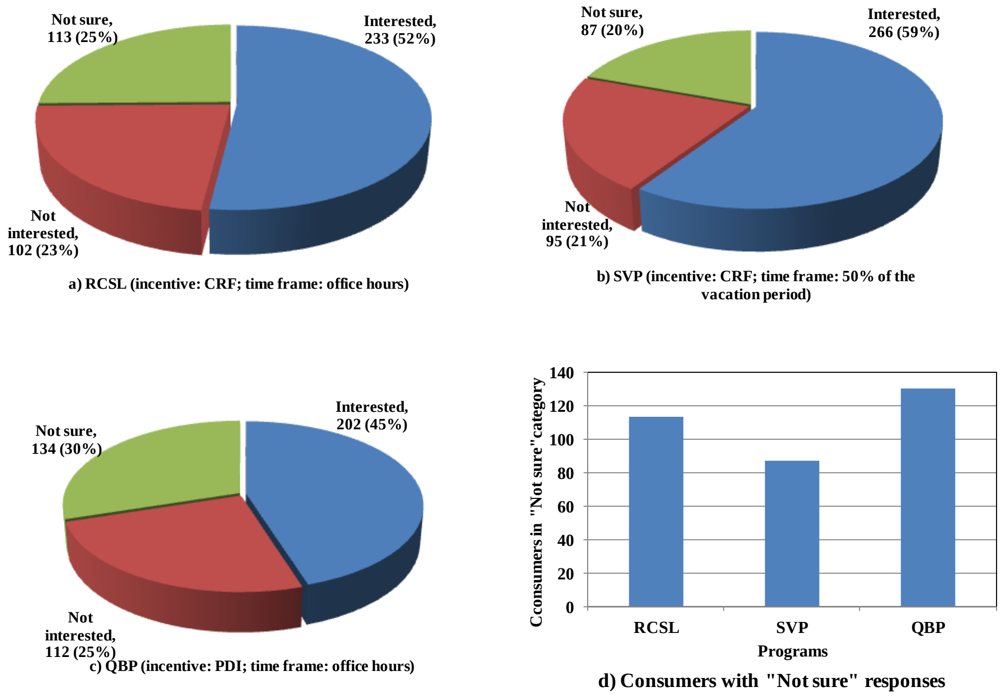

Fig. 7.2. Distribution of consumers' decision on willingness to participate

7.2.3. Policy for giving incentives

The success of the IBDR programs highly depends upon the effective distribution of incentives. As consumers showed interest in both MI and NMIs, all related aspects should be considered while framing the policy.

As most of the consumers selected CRF as the most preferred incentive scheme, a policy for formulating an appropriate amount of CRF for a certain amount of power reduction needs to be generated. This policy should cover the production cost, operation, and maintenance costs of the IBDR programs, time of the event, etc. The way of redeeming the CRF also needs to be detailed in the policy. Some of the practiced methods are monthly bill credit, yearly bill credit, and discounted electricity price [114].

The proposal of allocating CPs in proportion to consumer's power reduction was designed based on the experts' suggestions. Hence the feasibility of introducing them to a real market has to be evaluated. Undoubtedly, the introduction of such schemes in a market requires policy support. In the first stage, policy should be developed for calculating the CPs, which depends on many parameters that were used to calculate the CRF. The redemption of CPs is the real way of rewarding the consumers. The facility to accumulate a big amount of CPs without having a facility to utilize them will be disappointing and will backfire on the program's existence itself.

In this study, three ways of redeeming the CPs were suggested such as SSC, LDSR, and SDASP. Separate policies have to be prepared for all of these. As far as the SSCs are concerned, there should be appropriate coordination between different governmental agencies to put them into practice. For introducing LDSR also, an appropriate policy formulation is essential. Parameters, such as the minimum points required to qualify for the draw, the type of prizes, the way of recognizing consumers who contributed effectively, etc., need to be included in the policy. Subsidizing the energy efficient appliances requires a very strict policy, by which the importing/manufacturing of less efficient appliances can also be restricted [244]. Moreover, the percentage of discount against the redeemed points, the outlets for delivering energy efficient appliances and solar panels, etc., has to be specified in the policy.

7.2.4. Policy for power usage during the summer vacation

From the survey analyses, it was learned that most of the consumers prefer SVP as the best program among the suggested ones. This stressed the importance of formulating a policy for those who leave the country during the summer months without taking any EC measures. As per the responses received for the survey question 18, it was learned that around 68% of the consumers leave the country for four weeks or more during the summer season (Fig. 7.3). This opens a huge potential for EC during this period. The government can easily ensure the electricity reduction by imposing some penalties on the residents who travel during the summer season. However, all of the experts denied imposing any type of penalty for not participating in EC programs. A detailed study needs to be conducted before developing a policy for forcing consumers to reduce their consumption during this period.

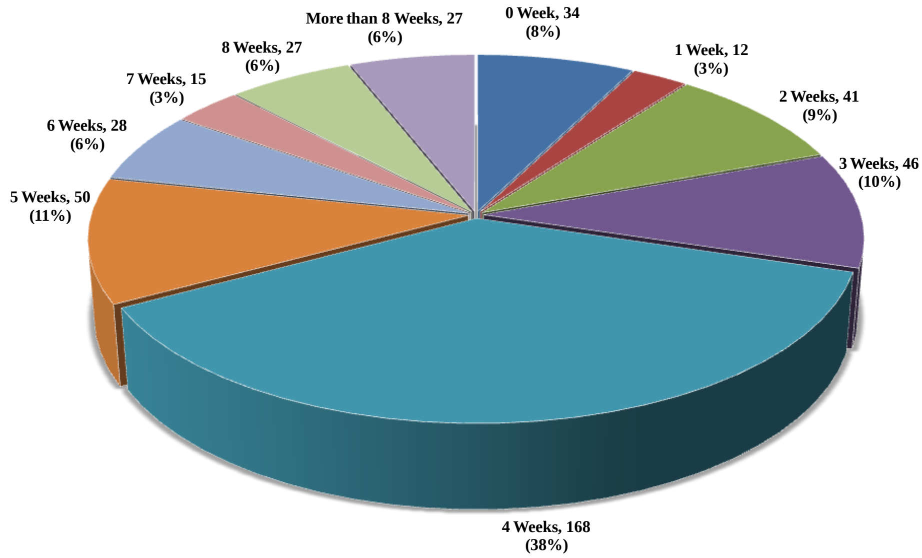

Fig. 7.3. Vacation pattern of different consumers

7.3. Relevance of new policies in Kuwait's electricity sector

The proposed IBDR programs are in line with Kuwait's second development plan 2015-2020, which also focuses on EC programs [395]. Being a rich economy that is highly committed to reducing its fossil fuel consumption, finding the required funding will not be a barrier to introduce such programs. As KES is handled by a government agency, MEW, the implementation of any new program will be an easy task. However, experts suggested that the MEW can consider giving subcontract to some third parties for the installation and maintenance part, by keeping the administration within its direct control. These third parties can act as aggregators and manage different IBDR events by interacting between MEW and consumers. Considering these strategies while developing an IBDR policy in Kuwait will also enable consumers with less technical capabilities to enroll in such programs.

On several occasions, the MEW has proven their capability to launch effective awareness programs, and "Trsheed" was one of the most discussed awareness programs ever launched in Kuwait [85]. A more focused awareness program may be required to be designed to identify the consumers in "not sure" and "not interested" groups. Accordingly, appropriate measures have to be formulated to make them interested in the IBDR programs by addressing all of their concerns.

The feasibilities of introducing CPs as an NMI have to be investigated further. The calculation of CPs could be easy as they can be related to the CRF incentive scheme. Since the redemption of CPs involves multiple governmental authorities/ministries, possible barriers and associated risks should be explored properly. Among the NMIs, most of the consumers preferred SDASP, which showed consumers' interest toward EC compared to other non-electricity related NMIs. This emphasizes the need for promoting SDASP in the EC policies. The proposed policy should have a provision for introducing an energy labeling facility, which will enable authorities to filter out less efficient appliances from the market. According to the carbon atlas of Kuwait, power and water sectors account for the 42% of carbon emission in the country due to its dependency on fossil fuels [396]. Promoting RE supported IBDR programs will not only help improve the environmental conditions but also help earn revenue by exporting the saved fuel. It was predicted that due to the availability of cloudless sky and prolonged sunny days, horizontal solar panels have the power generation potential of around 8 kWh/m^2 in Kuwait [397]. The preference of consumers toward SDASP shows their interest towards solar panels, and the power generation potential of solar panels in Kuwait demands the need for an appropriate policy in this subject for promoting solar panels.

Since CRF is identified as the most preferred incentive scheme, a dynamic way of calculating the power generation cost for Kuwait has to be evaluated as this is missing in the referred literature. Development of appropriate models will be useful for calculating the CRF optimally by considering different influencing variables.

As the peak power consumption happens during the summer season due to the extensive use of AC units and as the MEW is committed to meet the peak demand, it has kept standby gas turbines, which have a high operational cost and low thermal efficiency and account for 38.5 % of the total installed capacity [388]. Any power reduction in this period will significantly help reduce the operating and maintenance costs of the power plants. This emphasizes the importance of formulating an appropriate power usage policy for the people who travel during the summer season.

7.4. Summary

As the implementation of IBDR programs demands proper policy supports, based on the findings from document analysis, experts' interview, and survey analysis, the assessment of policies were formulated in four areas such as implementation, consumer-focused awareness, incentivization, and summer power usage. All of the policy requirements were detailed with the help of supporting information and their relevance to KES.

8. LIMITATIONS AND FUTURE WORKS

8.1. Introduction

The framework developed for introducing IBDR programs in Kuwait can be used as a reference for introducing such strategies in any new electricity market where IBDR programs are not yet implemented.

8.2. Limitations

Even though this study considered most of the aspects related to the IBDR implementation, it has the following limitations.

- This study is concentrated only on the residential sector; hence, it cannot be suitable to other sectors.
- There is no clarity on the amount of CRF to be offered to consumers for their contribution.
- The practicality of giving all the NMIs suggested in this study is not discussed here.
- Establishing a proper CBL and a continuous evaluation of it through proper M&V is highly required for calculating the power reduction and hence the incentives. The current study did not suggest any appropriate methodology for these two important aspects.

8.3. Scope of further research

To overcome the abovementioned limitations, studies in the following areas are recommended:

- By appropriately modifying the interview protocol and collecting data from experts, the results of this study can be used for developing an implementation framework for other sectors. The proposed study should include a separate survey-based data collection and analysis to find out the acceptance of consumers in corresponding sectors also.
- Development of a model for calculating the most suitable rate of CRF and CP is another important area of research.

- All the NMIs suggested in this study are found to be attractive to customers. A study to check the feasibility of introducing the suggested NMIs is highly recommended.
- An appropriate methodology for calculating CBL is a very important area of future research. The study may include the exploration of adequate measures to conduct M&V to ensure the accuracy of data and control system.

8.4. Summary

Even though the developed implementation framework is ready for implementation, this study identified the lack of clarity in some areas such as the calculation of CBL, CRF and CP; feasibilities of reimbursing the CP; and appropriate M&V procedures. Suitable future studies to fill the gap are also recommended.

9. CONCLUSIONS

The study results reveal that even in a subsidized electricity market, people can be motivated by offering both MI and NMIs. However, several barriers, such as fear, unwillingness, and indifference are expected from the consumers. To an extent, this can be overcome by introducing appropriate enablers such as ease, quality, aid, adequacy, awareness, customization, interaction, and demonstration.

As far as Kuwait's subsidized electricity market is concerned, prior to the design and implementation of any IBDR program, proper awareness needs to be created among consumers along with sufficient infrastructure development. From the study, it was revealed that consumers prefer MI to NMIs, while both of these can be considered while developing the program. While calculating the incentives, many market-specific factors, such as production cost, distribution cost, and transmission loss have to be considered.

The establishment of CBL is critical for calculating the incentives for consumers' contribution, which requires the development of proper methodologies. Instead of generalizing, the dwelling-based calculation needs to be carried out. Some of the other influencing parameters are the story of the building, type of the AC system, number of occupants and their occupancy type, the energy utilization capability of appliances used, etc.

Undoubtedly, the backbone of the IBDRPs is the reward given to the consumers for their participation, and hence the identified barriers and enablers need to be studied thoroughly for the success of implementation of any strategy based on the ITM.

AI, CAF, SM, and TWC are found to be the most relevant in all three stages of implementation, out of which CAF is the backbone of all other three parameters. The amount and the source of CAF will vary from market to market. In the ideal case, the government should make necessary arrangements to provide the required infrastructure and bear the costs associated with it. While upgrading the infrastructure, the government may consider the latest technologies including smart grids, SM, common TWC system, etc. Additionally, the government should monitor the program and ensure that all participants are rewarded according to the contract.

The hypothesis test rejected the null hypothesis and accepted the alternate hypothesis, which is establishing an association between incentivization and load reduction. Among the three IBDR programs offered, SVP was accepted by most of the consumers followed by RCSL and QBP. Even though the consumers showed interest in NMIs, majority of them supported MI in return for their contribution.

Among the discussed programs and policies, electricity usage policies for the summer season have to be considered with high importance as they will not have any negative impact on the comfort of consumers. All policies should have the required guidelines for the preparation of contracts between consumers and implementers/aggregators.

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APPENDICES

A1. Final protocol questions for document analysis

What are the features of DLC?

What are the features of IL?

What are the features of DBP?

What are the benefits to the utility companies?

What are the benefits to the country?

What are the benefits to the consumers?

What are the benefits to the environment?

What are the challenges related to government support?

What are the challenges related to consumer participation?

What are the challenges related to awareness/marketing?

What are the challenges related to eligibility constraints?

What are the challenges related to policies and regulations?

What are the technical requirements?

What are the requirements for estimating saving and load reduction potential?

What are the requirements for preparing consumers?

Who should implement the program?

What are the ways to enroll consumers?

What are the challenges related to technical/reliability?

What are the challenges related to cost and funding?

What are the challenges related to load curtailing?

What are the infrastructure related requirements?

What types of expert manpower is required?

What are the factors to be considered while tailoring the program?

What are the channels to be used for communicating with participants?

What are the factors to be considered while installing the hardware?

What are the challenges related to device workability?

What are the challenges related to ensuring consumer comfort?

What are the methods to handle operational issues?

What are the different maintenance activities to be carried out?

What are the factors to be monitored?

What are the factors to be considered while rewarding the consumers?

What are the ways to optimize the incentives given to consumers?

What are the factors to be considered for cost-benefit analysis?

What are the factors to be considered for imposing penalties?

A2. Illustration of familiarization report

Pre-implementation challenges: Policies and regulations

What are the features of DLC?					
Sl No.	**Details of the document**		**Page No**	**Paragraph/ line no**	**Text in Vivo**
1	File Name	Market potential study for Water_Heater_Demand_Management	1	1,4	With such a high saturation of electric water heating nationwide, direct load control for water heaters has high potential for reducing peak demand, especially to help offset summer peaking driven by electric air conditioning use.
			4	1,1	The National Assessment of Demand Response Potential study published by the Federal Energy Regulatory Commission (FERC) found that direct load control programs for residential central air conditioning could have participation rates as high as 25% without the benefit of any favorable pricing programs
			5	2,3	Figure 1 below displays potential peak demand savings for an electric water heater direct load control program. If a 25% participation rate was reached nationwide, as suggested by the FERC study (for air conditioning), the resulting savings would be about 5,300 MW of peak demand reduction, which equates to about $424M (424 million dollars) in utility savings due to reduced on-peak generation needs.
	Citation	Farrell Troutfetter R. Market Potential Study for Water Heater Demand Management 2008. http://c.ymcdn.com/sites/www.peakload.org/resource/resmgr/PLMA_Water_Heater_Demand_Man.pdf (accessed May 24, 2016).	6	1,3	Great River Energy offers customers two options, their Off-Peak Water Heating Program, or a Peak Shave Water Heating Program 8 . The Off-Peak Water Heating Program cycles high efficiency electric water heaters (with sufficient storage capacity) off over a 16 hour on-peak period.
			6	2,1	While the Peak Shave Water Heating Program acts similar to a typical direct load control program, the Off-Peak Water Heating Program is a load shifting program. The Off-Peak Water Heating Program permanently moves the demand of participants to off-peak periods on a year-round basis.
			6	4,1	Electric water heaters also have the potential to efficiently utilize and build demand for renewable energy. Residential water heaters, unlike most home appliances and HVAC equipment, are effectively retaining or delivering hot water on a continuous year-round basis. Since they can be sufficiently modified such that they operate only during off-peak hours, the potential exists for them to be configured in such a way so as to utilize renewable energy generated off-peak
			7	1,12	Outfitting large-capacity, high-efficiency electric water heaters with the described controls would allow for the water heaters to be operated only during prescribed off-peak periods, and/or at times when renewable generation, such as wind, is occurring off-peak.
2	File Name	Forecasting_DLC in energy markets	2	2,1	Effective DLC is widely used to reduce peak load, which delays the need to build power plants or transmission lines. However, in recent years it is also used as reserve capacity for contingencies in the grid
			1	2,3	One type of demand response is direct load control (DLC) where electrical appliances are remotely powered of
			1	2,6	Unlike generation where the supply is deterministic (barring events that lead to a forced outage), the DLC resource is uncertain and must be forecasted
			1	2,8	While generators are paid according to the quantity of energy supplied, DLC participants are paid based on the amount of load reduction 1 . Load reductions cannot be directly measured; they are estimated by subtracting actual load during a DLC event
	Citation	Horowitz S, Mauch B, Sowell F. Forecasting For Direct Load Control In Energy Markets 2013:1-29.	2	2,4	PJM, a northeastern grid in the US, provides 20% of its contingency reserves with DLC resources
			2	2,5	DLC can also be used to adjust load as a means of balancing variability of wind and solar resources
			2	2,9	increased use of DLC will require more accurate load forecasting techniques that are easy to implement, like the method we develop in this work. Model accuracy is needed over a range of temperatures since DLC can be called for peak load reductions at high temperatures as well as contingency reserves at lower temperatures.
			2	3,1	ACs are well suited for DLC since they can be powered off for short periods of time without much customer discomfort. A California utility surveyed customers during a pilot study and found the majority did not notice DLC events lasting 15 minutes or less
			2	2,4	Advanced electric meters (i.e. smart meters) allow finer control over electric loads and provide more load data which will enable greater use of DLC in electric grids
			3	3,1	Accurate load forecasts are essential for efficient DLC
			3	3,3	This is an estimate for a counterfactual event, i.e. the expected load conditional on the DLC event not happening. Inaccuracies in the CBL lead to incorrect and unfair payments.
			3	3,8	Reducing uncertainty in the load forecasts will become more important as DLC resources provide more ancillary services to help balance the smart electricity grid
			6	5,3	Customers received notice 24 hours prior to a DLC event. During the time period covered in the data, 8 DLC events occurred ranging in duration from one to four hours. Customers had the option of overriding the signal if they wanted. H
			7	2,2	Most current residential DLC programs are concerned with peak shaving, i.e. reducing demand only when temperature are extremely high.

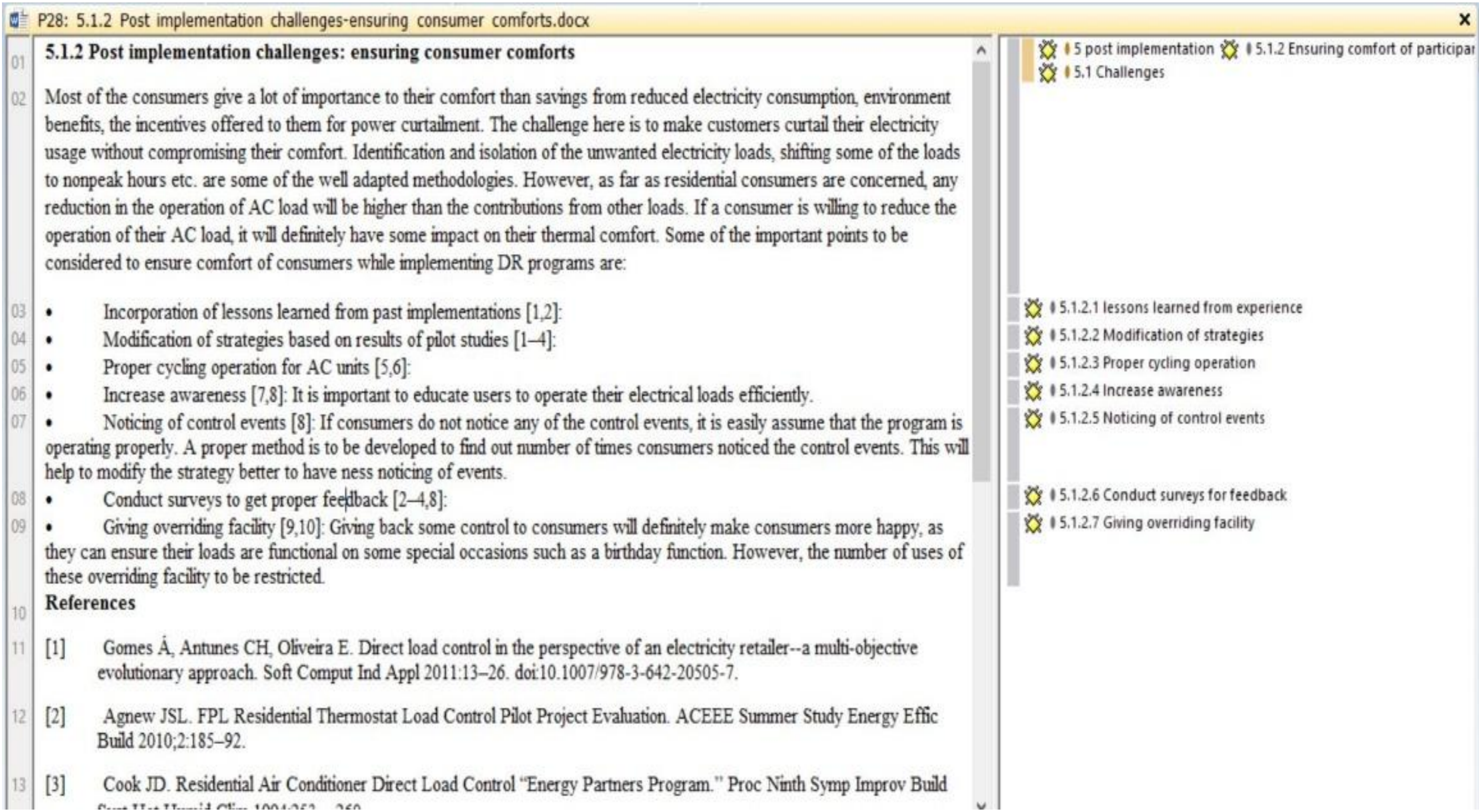
A3. Illustration of indexing

3.2	Pre-implementation requirements								
		3.2.1	Technical						
				3.2.1.1	Energy efficient loads				
						3.2.1.1.1	Permanent decommissioning of old equipment		
						3.2.1.1.2	Exchange of old appliances with new energy efficient ones		
						3.2.1.1.3	Promotion of energy star appliances		
				3.2.1.2	Load specific control devices				
						3.2.1.2.1	Programmable thermostats		
						3.2.1.2.2	Control switches		
				3.2.1.3	Smart meters				
				3.2.1.4	Two-way communication				
						3.2.1.4.1	Cell phones		
						3.2.1.4.2	Internet connection		
				3.2.1.5	Optional				
						3.2.1.5.1	Smart grid		
						3.2.1.5.2	Energy management system		
						3.2.1.5.3	Home area networks		
						3.2.1.5.4	In home displays		
						3.2.1.5.5	Control system for load shaping		
						3.2.1.5.6	Integration of DR resources		
								3.2.1.5.6.1	Integration of micro-generation units
								3.2.1.5.6.2	Electricity storage facility
								3.2.1.5.6.3	Battery operated vehicles
		3.2.2	Estimation of load and saving potential						
				3.2.2.1	Load prediction				
				3.2.2.2	Establishment of CBL				
		3.2.3	Preparing consumers						
				3.2.3.1	Ensure availability of smart meters				
				3.2.3.2	Ensure minimum load curtailing capability				
				3.2.3.3	Test the ability to curtail load				
				3.2.3.4	Availability of control devices				
				3.2.3.5	Establish proper communication				
				3.2.3.6	Health of inmates				

A4. Illustration of a transcript

What are the challenges related to consumer comfort?				
Sl No.		File Name and Reference	Text in Vivo	Content for transcript
1	File Name	Direct load control in the perspective of an electricity retailer – a multi-objective evolutionary approach	This characterization of load control actions has been often done based on information from past implementations, (costly) field experiments or pilot programs. Moreover, a cycling strategy has been frequently used with pre-determined on/off patterns applied to the loads under control. However, if the different (dynamic) usages of energy services are not taken into consideration the on/off constant patterns of cycling strategies increase the probability of causing discomfort to the end-users	5.1.2 Post implementation challenges: ensuring consumer comforts Most of the consumers give a lot of importance to their comfort than savings from reduced electricity consumption, environment benefits, the incentives offered to them for power curtailment. The challenge here is to make customers curtail their electricity usage without compromising their comfort. Identification and isolation of the unwanted electricity loads, shifting some of the loads to nonpeak hours etc.. are some of the well adapted methodologies. However, as far as residential consumers are concerned, any reduction in the operation of AC load will be higher than the contributions from other loads. If a consumer is willing to reduce the operation of their AC load, it will definitely have some impact on their thermal comfort. Some of the important points to be considered to ensure comfort of consumers while implementing DR programs are: • Incorporation of lessons learned from past implementations [1,2]: • Modification of strategies based on results of pilot studies [1–4]: • Proper cycling operation for AC units [5,6]: • Increase awareness [7,8]: It is important to educate users to operate their electrical loads efficiently. • Noticing of control events [8]: If consumers do not notice any of the control events, it is easily assume that the program is operating properly. A proper method is to be developed to find out number of times consumers noticed the control events. This will help to modify the strategy better to have ness noticing of events. • Conduct surveys to get proper feedback [2–4,8]: • Giving overriding facility [9,10]: Giving back some control to consumers will definitely make consumers more happy, as they can ensure their loads are functional on some special occasions such as a birthday function. However, the number of uses of these overriding facility to be restricted. References [1] Gomes Á, Antunes CH, Oliveira E. Direct load control in the perspective of an electricity retailer--a multi-objective evolutionary approach. Soft Comput Ind Appl 2011:13–26. doi:10.1007/978-3-642-20505-7. [2] Agnew JSL. FPL Residential Thermostat Load Control Pilot Project Evaluation. ACEEE Summer Study Energy Effic Build 2010;2:185–92. [3] Cook JD. Residential Air Conditioner Direct Load Control "Energy Partners Program." Proc Ninth Symp Improv Build Syst Hot Humid Clim 1994:253 – 260. [4] Herter K. Residential implementation of critical-peak pricing of electricity. Energy Policy 2007;35:2121–30. doi:10.1016/j.enpol.2006.06.019. [5] Crossley D. ETSA UTILITIES AIR CONDITIONER DIRECT LOAD CONTROL PROGRAM - AUSTRALIA 2003:1–16. http://www.ieadsm.org/article/etsa-utilities-air-conditioner-direct-load-control-programe/ (accessed May 14, 2016). [6] Müller D, Monti A, Stinner S, Schlösser T, Schütz T, Matthes P, et al. Demand side management for city districts. Build Environ 2015;91:283–93. doi:10.1016/j.buildenv.2015.03.026. [7] AEMC. Power of Choice - Giving Consumers Options in the Way they use Electricity. Sidney: 2012. [8] KEMA. Comparison of California Investor- Owned-Utility (IOU) Direct Load Control (DLC) Programs 2010. http://www.calmac.org/publications/Final_report_for_California_DLC_Program_Comparison.pdf (accessed May 14, 2016). [9] Okwelum EO. Three essays on the incentive structure of energy conservation programs. Diss Abstr Int Sect A Humanit Soc Sci 2015;76. [10] Chatla R. The place of consumers: how to make demand response programs attractive ? 2010. http://blog.ijenko.com/2015/12/10/the-place-of-consumers-how-to-make-demand-response-programs-attractive/ (accessed July 16, 2017).
	Citation	Gomes A, Antunes CH, Oliveira E. Direct load control in the perspective of an electricity retailer – a multi-objective evolutionary approach. Soft Comput Ind Appl 2011:438. doi:10.1007/978-3-642-20505-7		
2	File Name	ETSA UTILITIES AIR CONDITIONER DIRECT LOAD COONTROL PROGRAM - Australia	Switching of 15 minutes off in 30 minutes was tested on four occasions and no customer complaints were received regarding comfort levels. ETSA Utilities concluded that residential air conditioning customers can sustain that level of switching	
	Citation	Crossley D. ETSA UTILITIES AIR CONDITIONER DIRECT LOAD CONTROL PROGRAM - AUSTRALIA 2003:1–16. http://www.ieadsm.org/article/etsa-utilities-air-conditioner-direct-load-control-programe/ (accessed May 14, 2016).		
3	File Name	Power of choice review - giving consumers Options in the Way they use Electricity	The ability of consumers to easily access and have sufficient and relevant information about their consumption will help• improve awareness of electricity consumption and use patterns;• enable more informed choices about different DSP products and services that better suit consumers circumstances and needs; and• promote efficient retail electricity markets through better products and services available to consumers	
	Citation	AEMC. Power of Choice - Giving Consumers Options in the Way they use Electricity. Sidney: 2012.		
4	File Name	Final_report_for_California_DLC_Program_Comparison	Whether respondents knew how the program worked: The SCE and SDG&E programs have complex program designs – with multiple cycling or event-frequency options per customer type. The process evaluations found that these utilities inherently have a tougher challenge in educating customers on how the programs work, compared to a simpler program design. The evaluations found that both these programs needed to improve their educational efforts since many participants (and in the case of SDG&E non-participants and dropouts) were not clear on key program details.	
	Citation	KEMA. Comparison of California Investor- Owned-Utility (IOU) Direct Load Control (DLC) Programs 2010. http://www.calmac.org/publications/Final_report_for_California_DLC_Program_Comparison.pdf (accessed May 14, 2016).	Noticing the control events: The percentage of program participants noticing the control events was 34 percent for PG&E (2008 non-EM&V participants), 36 percent for SCE (2005 participants), and 43 percent for SDG&E (2008 participants). • Comfort levels during control events: Seventy-two percent of the SCE participants (2005 participants) who noticed the control event reported being uncomfortable compared to 40 percent of the PG&E participants (2008 non-EMV participants) and 47 percent of SDG&E participants (2008 participants)	
5	File Name	Three essays on the incentive structure of energy conservation programs	Although, we find that the result of customers' behavioral response and the interaction of technology under a non-monetary intervention results in the diminution of conservation gains, the fact that customers may learn to precool their homes at higher temperatures could also provide policy benefits. First, the fact that households precool their homes under a DLC only program is an indication that residential households may be averse to relinquishing complete control of their air conditioners to utilities during summer peak times. Perhaps giving consumers back some type of control during curtailment hours could be one way of improving the performance as it could provide additional avenues for adjustment. Second, the evidence of precooling suggests that utilities should bundle some sort of time-varying price incentive into DLC program to make them more efficient	
	Citation	Okwelum EO. Three essays on the incentive structure of energy conservation programs. Diss Abstr Int Sect A Humanit Soc Sci 2015;76.		
6	File Name	Demand side management for city districts-Building and Environment 2015	In the case of a technical storage (e.g. hotwater tank), the minimum temperature of the system is indirectly influenced by the thermal comfort of the occupants	
	Citation	Müller D, Monti A, Stinner S, Schlösser T, Schütz T, Matthes P, et al. Demand side management for city districts. Build Environ 2015;91:283–93. doi:10.1016/j.buildenv.2015.03.026	The autonomous building agents execute the agreed schedules while ensuring that the thermal comfort of the residents and the technical restrictions of the energy conversion units are not violated because of the forecast errors	
			These restrictions are mostly due to maximum and minimum temperatures that can be provided by the heat generator or are required for thermal comfort constraints	
7	File Name	FPL residential thermostat load control pilot project evaluation	FPL tracked the pilot's telephone and contractor support rates and found that the thermostat-based pilot required significantly more support than FPL's current switch-based On Call program	
	Citation	Agnew JSL. FPL Residential Thermostat Load Control Pilot Project Evaluation. ACEEE Summer Study Energy Effic Build 2010;2:185–92.	Overall satisfaction was consistently rated "very satisfied" by over 68% of participants over the course of the pilot. 4.75%	
			Participants in FPL's thermostat pilot placed great importance on its ability to help save on their electric bill. The gap between the ability to save energy and consumer expectations presents a significant challenge to any future program utilizing programmable thermostats.	
8	File Name	ESL-HH-94-05-31	With respect to customer acceptance of the program, pilot participants told HL&P through monthly surveys that generally they were very satisfied with the pilot program.	
	Citation	Cook JD. Residential Air Conditioner Direct Load Control "Energy Partners Program." Proc Ninth Symp Improv Build Syst Hot Humid Clim 1994:253 – 260.	Based upon the results of the 1991 pilot program, a thorough benefit-cost analysis was conducted for a proposed formal program. As a result of the success of the 1991 pilot program and the favorable results of the benefit-cost analysis, HL&P elected to pursue the formal implementation of residential direct control of air conditioners in the HL&P service area	
9	File Name	Residential implementation of critical-peak pricing of electricity (ref 60)	Using a subset of data from the California Statewide Pricing Pilot of 2003–04, average load change during summer events, annual percent bill change, and postexperiment satisfaction ratings are calculated across six customer segments, categorized by historical usage and income levels.	
	Citation	Herter K. Residential implementation of critical-peak pricing of electricity. Energy Policy 2007;35:2121–30. doi:10.1016/j.enpol.2006.06.019.	Although the voluntary pilot study investigated here received uniformly high satisfaction ratings across customer segments, consideration of a mandatory CPP tariff should be particularly wary of customer and political backlash	
			For example, there was no attempt to define or measure any variable, for example ''agreeable- ness'' or ''responsiveness'', that might predispose customers to participate in the pilot, respond to prices, and give the program a high satisfaction rating. Thus, extrapolation of these values to a voluntary program within California is supportable, but extrapolation of these values to any other implementation scheme or geographic area should be done with caution.	
			the program satisfaction rating for each of the 151 customers in the analytic sample that also answered the post-pilot survey	
10	File Name	The place of consumers_ how to make demand response programs attractive?	If opt?out (withdraw from an operation) opportunity is given to users, it has to be simple and immediate, without repetitive clicks and deep navigation, and the same for overriding actions (for e.g. to restart an HVAC switched off during the DR event).	
	Citation	Chatla R. The place of consumers: how to make demand response programs attractive ? 2010. http://blog.ijenko.com/2015/12/10/the-place-of-consumers-how-to-make-demand-response-programs-attractive/ (accessed July 16, 2017)	This flexibility given to consumers to opt?out or override may look like a risk for the system reliability. Sociological studies conducted during the Modelec project reveal that, on the contrary, the feeling of keeping control over its own comfort contributes into maintaining a high level of involvement and, consequently, increasing the level of participation and engagement.	

A5. Illustration of manual/In vivo coding of transcripts



P28: 5.1.2 Post implementation challenges-ensuring consumer comforts.docx

01 **5.1.2 Post implementation challenges: ensuring consumer comforts**

02 Most of the consumers give a lot of importance to their comfort than savings from reduced electricity consumption, environment benefits, the incentives offered to them for power curtailment. The challenge here is to make customers curtail their electricity usage without compromising their comfort. Identification and isolation of the unwanted electricity loads, shifting some of the loads to nonpeak hours etc. are some of the well adapted methodologies. However, as far as residential consumers are concerned, any reduction in the operation of AC load will be higher than the contributions from other loads. If a consumer is willing to reduce the operation of their AC load, it will definitely have some impact on their thermal comfort. Some of the important points to be considered to ensure comfort of consumers while implementing DR programs are:

03 • Incorporation of lessons learned from past implementations [1,2]:

04 • Modification of strategies based on results of pilot studies [1–4]:

05 • Proper cycling operation for AC units [5,6]:

06 • Increase awareness [7,8]: It is important to educate users to operate their electrical loads efficiently.

07 • Noticing of control events [8]: If consumers do not notice any of the control events, it is easily assume that the program is operating properly. A proper method is to be developed to find out number of times consumers noticed the control events. This will help to modify the strategy better to have ness noticing of events.

08 • Conduct surveys to get proper feedback [2–4,8]:

09 • Giving overriding facility [9,10]: Giving back some control to consumers will definitely make consumers more happy, as they can ensure their loads are functional on some special occasions such as a birthday function. However, the number of uses of these overriding facility to be restricted.

10 **References**

11 [1] Gomes Á, Antunes CH, Oliveira E. Direct load control in the perspective of an electricity retailer--a multi-objective evolutionary approach. Soft Comput Ind Appl 2011:13–26. doi:10.1007/978-3-642-20505-7.

12 [2] Agnew JSL. FPL Residential Thermostat Load Control Pilot Project Evaluation. ACEEE Summer Study Energy Effic Build 2010;2:185–92.

13 [3] Cook JD. Residential Air Conditioner Direct Load Control "Energy Partners Program." Proc Ninth Symp Improv Build

Appendix A6. Code list of document analysis

Ability to reduce load	Comfort/ inconvenience cost
Access to premises	Commercial
Accurate baseload calculation	Communication system
Activities	Communication with participants
Aggregators	Community education program
Amount of reduction	Conduct surveys for feedback
Analyzing methods	Conserve reserves
Assistance to states	Consumer awareness/marketing
Attractive incentives	Consumer education
Automatic	Consumer participation
Availability of control devices	Consumer retention
Availability of hardware	Continuous planning
Backup generators	Continuous updating of strategies
Balance in grid	Contract
Battery operated vehicles	Contractual commitment
Behavioral change	Control based
Benefits for country	Control devices
Benefits for environment	Control devices and software
Benefits for utilities	Control switches
Benefits to consumers	Control system for load shaping
Better load forecasts	Control through on/off switches
Call center	Corrective maintenance
Capital Benefits	Cost
Catchy slogans	Cost and funding
Cell phones	Cost-benefit analysis
Channel for investment recovery	Create more jobs
Channels	Customer engagement
Channels for communication	Customer satisfaction
Clarity of goals	Customized marketing
Coalition with private companies	Cycling operation

Data transfer charges	Emergency load reduction
Day-ahead program	Encourage volunteer participation
Day-of program	Energy efficient loads
Demand bidding program (DBP)	Energy management system
Define the role of different stakeholders	Enrollment
Delay construction of new power plants	Ensure availability of smart meters
Delay in building new transmission line	Ensure minimum load curtailing capability
Delay in construction	Ensure reliable data security
Details of incentives	Ensuring comfort of participants
Development of national communication program	Estimation of load and saving potential
Development of standards, codes, and protocols	Exchange old equipment with energy efficient ones
Direct mail	Ensuring device workability
Discounted electricity rate	Ensuring timely response
Distribution	Environmentally conscious
Direct load control (DLC)	Establish communication
Economics	Establishing customer baseline
Effectiveness of program	Establishment of national forum
Efficiency	Event-specific cost
Efficient equipment	Exception from power outage
Efficient usage of electricity	Expert manpower
Electricity consumption	Face to face meetings
Electricity demand	Factors
Electricity for more consumers	Failure in load curtailing
Electricity price variation	Fair payment of incentives
Electricity storage facility	Few Kilo-Watts
Eligibility	Field support
Eligibility constraints	Financial benefits

Financial commitment	Improvement opportunities
Financial incentives	Income-based
Financial support for technical upgradation	Increase awareness
For using energy efficient products	Increased contingency reserve
Free electricity	Increased electricity price
Free hardware	Increased load factor
Frequency balancing	Increased network reliability
Frequency of events	Industrial
From direct electricity bills	Influencing parameters
From incentives	Infrastructure upgradation (optional)
Fund availability	In-home displays
Giving overriding facility	Initial cost
Governmental support	Instant reduction
Greater control on electricity bill	Integration
Handle operational issues	Integration of DR resources
Hardware installation	Integration of microgeneration units
Healthy inmates	Integration of renewable energy
High awareness on program features	Interaction between participants and implementers
Home area networks	Internet connection
House of worship	Involvement of aggregators
Interruptible load (IL)	Lack of methodology for CBL
Implementation	Language
Implementer	Large agricultural
Improper utilization of aggregation	Less air pollution
Improved corporate social responsibility	Lack of plans for technology upgradation
Improved efficiency	Less outages
Improved reliability and reduced blackouts	Less import of fossil fuel for consuming countries
Improved social commitment	Less working of AC units

Less working of appliances	Minimum contract period
Lessons learned from experience	Minimum duration of 2 hours
Level of compromise	Minimum load
Load prediction	Minimum load curtailment of 1 kW
Load specific control devices	Minimum load reduction of 100 kW
Load-based	Minimum power reduction capability
Load-based incentives	Modification of strategies
Local	Monetary fine
Local advertisements	Monitoring
Local events	Monthly bill credits
Long-term planning	More ancillary services
Low electricity consumption	More business opportunities
Low environmental emissions	More export of fossil fuel for oil producing countries
Low GHG emissions	More fuel reserve
Low stress in grid	More profit
Low use of chlorofluorocarbon	Necessary permissions
Maintenance	Non-acceptance of DR as an energy resource
Make events unnoticeable	Non-governmental organizations
Manual	Non-thermostatically controllable loads
Market conditions	Notice duration
Marketing	Noticing of control events
Measurement and verification (M&V)	Number of events
Measurement and verification charges	On/off control
Meeting objectives	Ongoing program cost
Meeting regulatory requirements	Onsite generator
Meeting specific objectives	Operational benefits
Metering/communication system upgrade	Optimizing incentives
Methods	Optimizing programs

Optional	Protected vegetation
Other agencies	Provision for termination
Participants cost	Public-private partnership
Participants test	Quality of service provided
Payment to participants	Quantify actual savings
Penalties	Radio
Performance analysis	Rate impact test
Permanent decommissioning of old equipment	Reduced generation costs during peak time
Permissions	Reduced amenity/lost business cost
Personalized consultation	Real-time bidding
Plan for upgrading to smart meters	Reduced GHG emissions
Policies	Reduced off-peak generation costs
Policies/ regulations	Reducing demand and loss
post-implementation	Reducing peak power demand
Potential to integrate renewable energy	Re-establishment of customer baseload
Pre-implementation	Reduction in per capita electricity consumption
Preliminary information on load	Reduction in electricity price
Preparing consumers	Re-enrollment to the program
Pre-requisites are met	Regional network congestion
Presence of aggregators	Reliability
Press conference	Remote tripping
Prevention of undesirable events	Repeated failure
Preventive maintenance	Requirements
Program administration	Rescheduling cost
Programmable thermostats	Residential
Project financial analysis theory	Resource characteristics
Promotion of EnergyStar labeled appliances	Restriction of low energy efficient products
Proper cycling operation	Reward for participants

Risk commitment	Technical
Risks	Technical and reliability
Risks for implementation	Technological
Schools	Television
Season	Test the ability to curtail load
Sector	Thermostatically controllable loads
Semi-automatic	Third parties
Set priority	Timeframe
Short notice	Total resource cost test
Single-hourly bidding	Training for decision makers
Smart grid	Transmission
Smart meter	Two-way communication
Social media	Type and level of incentives
Special care in government offices	Upgrading to prosumers
Special offers and gifts	Utility companies
Special privileges	Venues of mass campaign
Sponsor seminars and conferences	Way of imposing
Strategies	Weather conditions
Strategy development	Website
System cost	Willingness to accept remote control
Systems integration	Willingness to participate
Tailoring programs	Willingness to pay penalty
Targets	Word of mouth

A7. Questions for semi-structured interview

Common questions for implementing IBDRP in Kuwait

1. Worldwide, incentive-based demand response programs (IBDRP) are implemented in various sectors. Which are the sectors to be considered for DR programs in Kuwait?

2. One of the objectives of introducing IBDRP is to reduce peak power reduction. What is the appropriate control timing for each sector?

3. Considering the dedication of the end users, how effectively can we bring down the electricity consumption in each sector?

4. IBRP give the opportunity to save electricity in 24 hours, in every season (especially summer). According to your view, what is the period (time/season), where electricity is mostly wasted in residential sector?

5. In Kuwait, the entire electricity market (from production to bill collection) is being carried out by a single agency. Who should implement the IBDRP in Kuwait? In many places, where the individual load is small, an aggregator act in between the utility companies and the consumers to combine loads of many buildings together to make it a sizable amount. In this case, aggregators do coordination between the utility companies and consumers. What is the role of aggregators in the Kuwait's electricity market?

6. Awareness and marketing are the two important factors for attracting consumers for participating in the program. How to market the program? What are the channels?

7. What points to be added in the awareness/marketing program to inform the building owner about the risks such as financial commitment for procuring some hardware (depends upon the program), penalties if participants do not perform as agreed, etc. associated with participation in demand response programs.

8. Without consumer willingness, no program can be implemented. How to ensure consumer participation?

9. What are the factors influencing consumer willingness?

10. What are the major risks associated with consumers, while participating in the program?

11. Based on the most commonly used loads in the residential sector, can you identify the technical requirements for implementing IBDRP?

12. Effective and timely communication between the participants and implementer is a pre-requisite for the successful implementation of the IBDRP. What are the possible methods for ensuring effective communication between implementer and participants?

13. Every consumer has different priorities and preferences. What are the factors to be considered while tailoring (customizing) the program?

14. How to enroll consumers?

15. Without governmental support, implementing such a huge program is not possible. How can government contribute to making the program successful?

16. Since there is no direct way to measure the actual power reduction as a result of IBDRP, a customer baseline (CBL) need to be established. If any error in calculation occurs, may lead to over-payment or underpayment to the participants. How to ensure CBL is calculated accurately?

17. During the implementation stage, many other factors, such as retrofit work, unplanned vacation plan, etc. may influence the power reduction. How to filter it out for the benefit of the implementer.

18. How will residents respond to nonmonetary incentive methods?

    a. Please suggest three most suitable nonmonetary incentives for reducing one kWh of electricity.

19. How will residents respond to monetary incentive methods?

a. Please suggest three most suitable rates for reducing one kWh electricity

20. There are different methods, such as monthly payment, monthly bill credit, etc. are used worldwide to pay back the financial incentives to the participants. How to calculate and distribute financial incentives properly?

21. It is obvious that for any reduction in peak hours will have more impact and should be rewarded accordingly. How to link the incentives with different timing?

22. Most of the IBDRP are supported by some technical equipment/devices. How to ensure the workability of the program in this aspect?

23. Any program implementation (especially for the first time) requires good financial support. How to find out the expenses/fund and cost involved in the program?

24. What is the initial cost expected?

25. What is the operational cost required?

26. The Kuwait authorities or implementers need to develop methods that drastically reduce installation cost, improve serviceability, and reduce maintenance needs of the control systems. How can we optimize the installation and maintenance of the system?

27. In many cases, development of the final control strategy is the result of several iterations. In your view, how to optimize control strategies?

28. How to make improvements in the IBDRP?

29. Smart grid and integration of renewable energy are not mandatory for the IBDRP. By considering Kuwait condition and the availability of different types of renewable energy sources, how much important is the smart grid and integration of renewable energy into it.

30. If renewable energy sources are introduced into the system, how can we optimize the integration of on-site generation with the program?

31. What are the factors to be considered while preparing a contract between implementer and participant?

32. How participants will react if implementer wanted to impose penalties for non-compliance with contractual obligations.

33. By adding more automation, it is evident that the performance will be more efficient, leading to more maintenance challenges. How important is the home energy management system (HEMS) for implementing this type of new programs?

34. Meeting the objective of the program is one of the aims of any program implementations. How to evaluate the effectiveness of the program?

35. Increasing participation will lead to considerable reduction in the load, which will affect the load curve. What are the risks associated with it and how can we handle it.

36. How to calculate the cost-effectiveness and payback period for consumers' investments?

37. Success of the program depends on the support of the consumers, which is influenced by their basic behavior. How to endure the behavioral habits are not changed as time passes?

Additional questions:

Occupancy based direct load control for residential sector / summer vacation plan for residential sector

1. What type of control devices to be installed?

2. How to implement the program remotely?

3. What are the expected challenges?

Additional questions:

Summer vacation plan for the residential sector

1. How much is the minimum appropriate duration (vacation plan) for the program?

2. How to calculate customer baseline as it is different to the regular occupancy days?

3. How appropriate is to impose travel ban for the non-participants?

4. How can we ensure the house interiors are not affected by the implementation?

Additional questions: Quick bidding program

1. What is the appropriate time gap between bid and event?

2. How implementer and the participants interact effectively, in a short span of time?

3. If a program is designed in such a way, that implementer identifies their target load to reduce and set some incentives for the interested bidders to participate,

   a. How to implement such a program?

   b. What are the expected challenges?

4. If a program is designed in such a way, that implementer identifies their target load to reduce and ask consumers to give bids based on consumers' expectation. After receiving the bids, if implementer needs to take decisions,

   a. What are the parameters to be considered?

   b. How to implement such a program?

   c. What are the expected challenges?

Appendix A8. Code list of experts' interviews

15 minutes	Campaign based on patriotism
Access to premises and data	Catchy slogans
Active reading of smart meter	Challenges
Adjusting electricity bill	CO_2 sensors
Advertisements in newspapers	Comfort
Age of inmates	Commercial
All major investments by implementer/third party	Commitments
Analyze individually	Communicating with participant
Appropriate planning	Community meetings
Attachment to belongings like home interior	Comparison with similar dwellings
Automatic based on benefits	Complicated program
Awareness	Continuous
Awareness on risks for participants	Continuous awareness to participants
Awareness/marketing	Continuous data analysis
Based on savings achieved	Continuous monitoring
Based on the complaints registered by consumers	Continuous data monitoring and analysis
Behavioral aspects	Control devices
Behavioral changes of participants	Control timing
Better behavioral change	Cooperation from participants
Bidding program	Cost involved
Bulletin boards	Cost optimization
By creating interactive Internet-based application	Cooperative society based mass campaign
By framing a good contract	Cost/fund
Calculation of exact reduction	Create an early adapters group
Calculation of price	Credit points
Call center	Cultural barriers

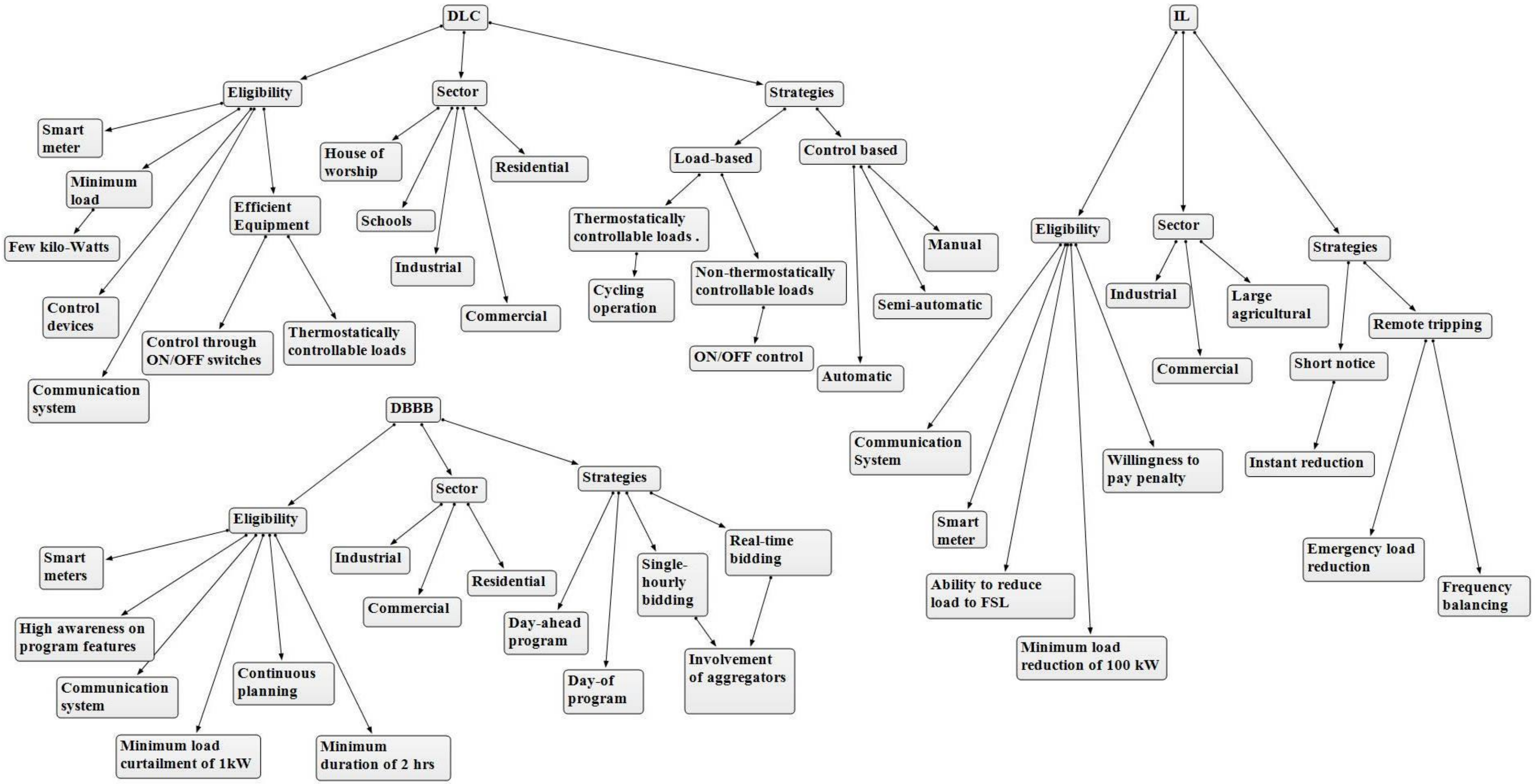
Cost-effectiveness for participants' investments	Filtering out power reduction from other means
Customizing programs	Finding alternate participants
Develop a communication plan	Forcefully by increasing tariff
Distribution of monetary incentives	Free stuff are not valuable
Dynamic incentive calculation	Funding
Easily visible way	Gap between bid and event
Education level	Getting correct bids
Effective communication	Good planning
Encourage all means of power reduction	Give special discount for retrofitting existing buildings
Energy utilization index	Government
Enroll consumers	Government policy
Ensure consumer participation	Government support
Ensuring device workability	Governmental
Establishing CBL	Governmental agency
Evaluate the effectiveness of the program	Governmental policy
Expectation of high profits	Habits and behaviors
Experienced/qualified contractors	Health issues
Experimental pilot houses	Health of inmates
Factors influencing consumer willingness	Health of the people
Fear of financial commitment	Hidden cost
Fear of losing comfort	High income
Fear of penalties	High purchasing power
Fear of risks	Highly important
Fear of technologies	Highly interested
Fear to commit	Historical data
Finalizing acceptable rate	Home automation
Financial commitment to consumers	Implementer
Financial commitments	Implementers' responsibility

Incapable of managing unexpected events	Levelized cost of energy based life-cycle cost analysis
Importance of smart grid	Lottery draw
Increase tariffs	Maintain indoor comfort
Indirect penalties (increase tariff if fail to curtail)	Meeting demand during unexpected mass failure of program
Industrial	Maintenance cost
Infrastructure cost	Make it mandatory for new buildings
In-house display units	Make participants feel like owner
Initial cost	Make sure no penalties
Inspection by authorities	Media
Installation of RE units	Minimum 20 percentage
Integration of renewable energy	Minimum duration
Interaction with participants	Mobile applications
Intermittent operation of AC	Mobile phones
Internet	Model covering different aspects
Introduce gradually	Monthly credit to accounts
Introduce in government-funded housing projects	Model generation with several variables
Introduce storage facility	Most preferred implementer
Intruding to personal freedom	Most suitable sector
Invitation through messages	Most suitable timing
Involve private sector	Nationality
Involve third parties	Need for more automation
Iteration of the program and analysis	Neural network based model
Lack of dedication	No competition among suppliers
Lack of motivation	No experience of blackout
Late night social activities	No financial burden for participants
Less effective	No interest in "peanut' savings
Level of commitment	No preference to shift duties
Level of income	Non-office hours for office buildings
Load control program	Nonpeak hour incentives

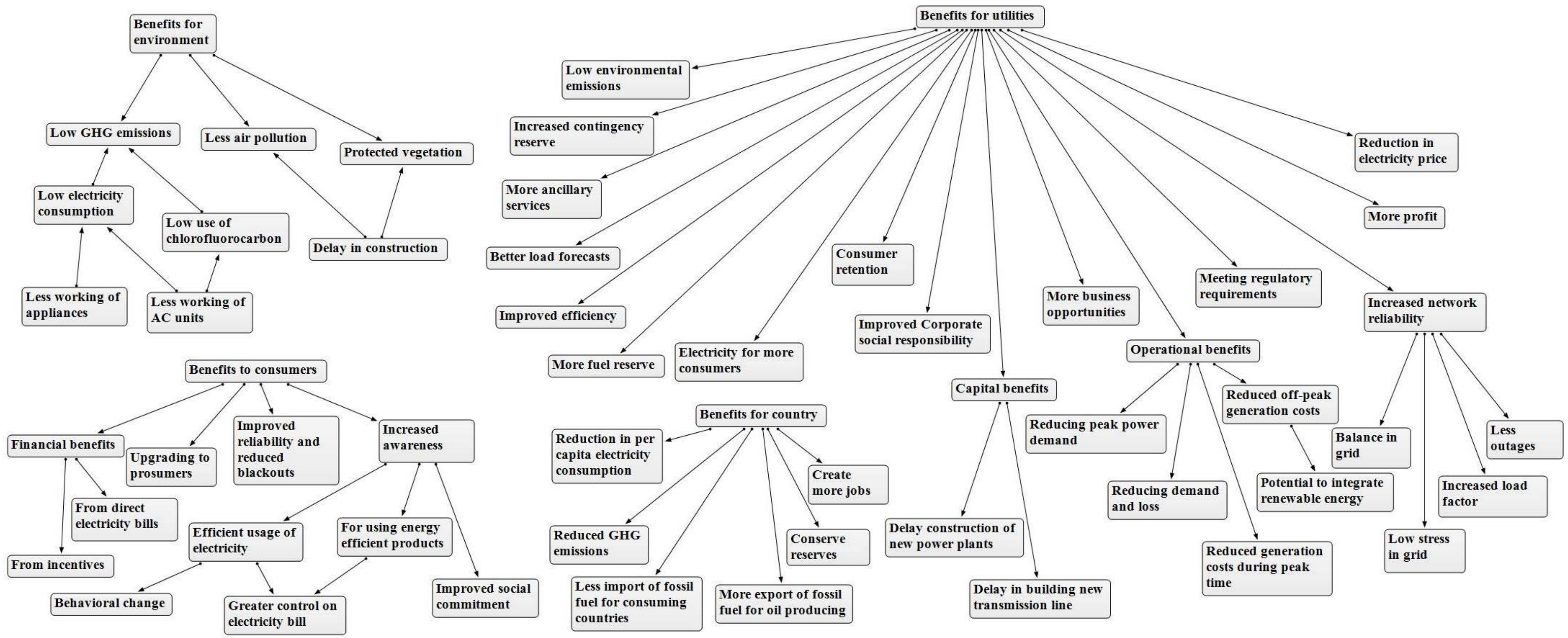
Non-exposure to other countries and their way of living	Price decided by implementer
Not recommended	Price demanded by participants
Number of occupants	Prior intimation for any changes
Number of people in the house	Priorities
Number of permitted overrides	Privacy issues
Occupancy sensors	Private companies
Operational complications in the program	Production and implementation cost-based model
Office hours for residential buildings	Program for summer
On/off switches	Program improvement
One hour	Program modification based on areas
One or two-year base data	Programmable thermostats
One week	Protect house interiors
One year data	Provide good home automation
Operational complications	Providing attractive incentives
Office hours	Recommended
Operational cost	Redeem in governmental offices
Optimize control strategies	Reduce interaction with participants
Optimizing overriding facility	Remote controlling
Optimum load selection	Residential
Optimum price selection	Resistance to be controlled by external sources
Optimum use of GCC grid	Resistance to get supervised
Participants' responsibility	Resources are taken for granted
Peak hour incentives	Response to monetary incentives
Peak time	Response to nonmonetary incentives
Penalties for non-compliance	Return for participants based on their compromise
Perfect design	Risk
Power consumption of similar houses	Risks for implementers
Preparation of contract	Risks for participants

Saving potential	Third party by profit sharing
School level	Time-based incentives
Scope of maintenance	Time-based model
Selection of participants	Timely communication
Set point offset	Travel ban
Size of the house	Troubleshooting
Special ministry for information/awareness	Trust on subsidized electricity price forever
Smart grid	Twenty four hours
Smart meters	Two weeks
Smartphone applications	Types of monetary incentives
Social media	Types of nonmonetary incentives
Solutions to meet risks	Unexpected events
Special calculation for vacation time	Unexpected programs in the house
Specific unit of existing electricity provider	Used to high comfort and living standard
Statistical awareness	Unwillingness to commit
Stress for participants	Up to 50 percentage
Subsidy for energy saving appliances	Vacation time
Subsidy for equipment	Vacation plan
Suitable sectors for Kuwait	Very big house area
Surveillance cameras	Wastage in residential sector
Survey	Web pages
Surveys	Well defined incentives
Tariffs	Well-designed contract
Technical issues	What you see you believe
Television programs and advertisements	Willingness to pay money for expensive home interiors
Technical requirements	Without violating privacy issues
Third party	YouTube advertisements

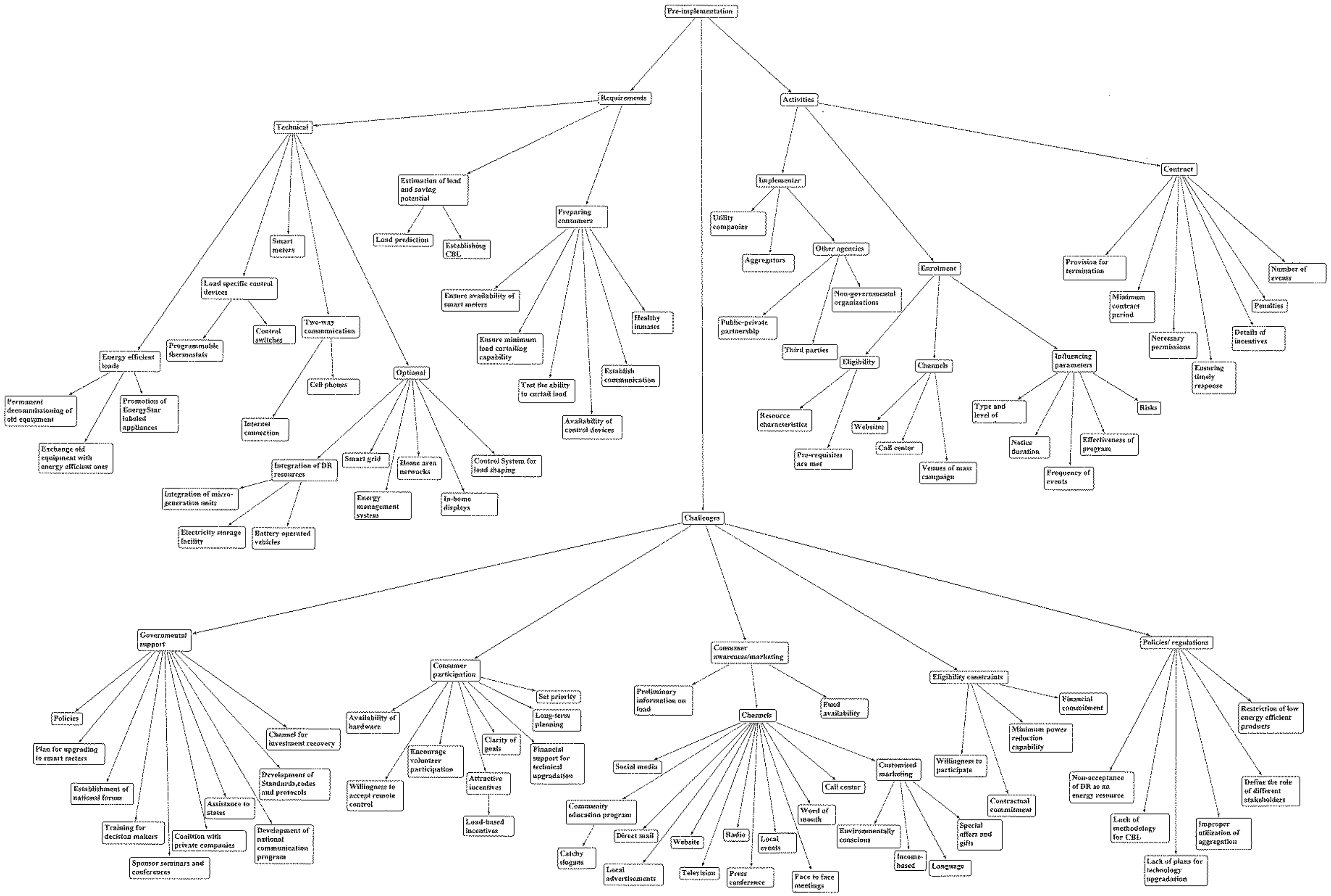
A9. Axial coding of the features of different incentive-based demand response programs



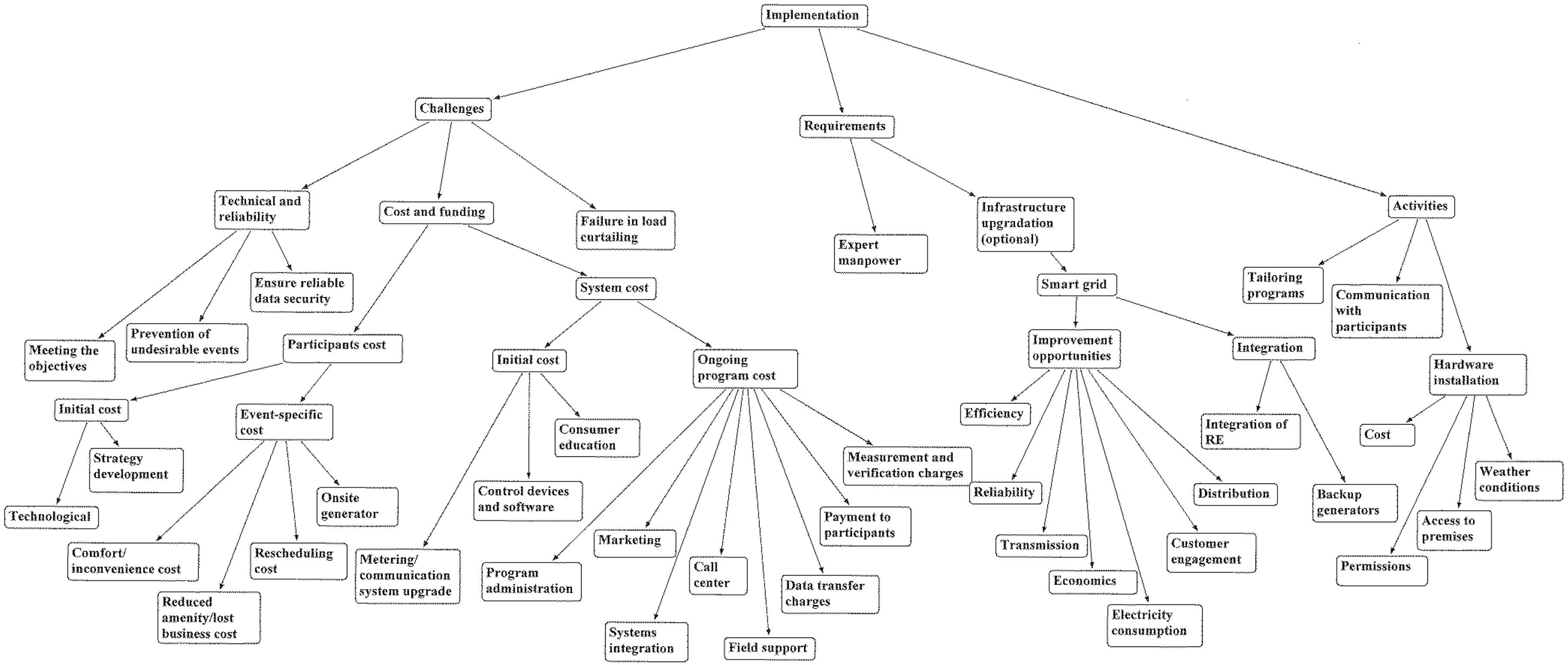
A10. Axial coding of the benefits of different incentive-based demand response programs



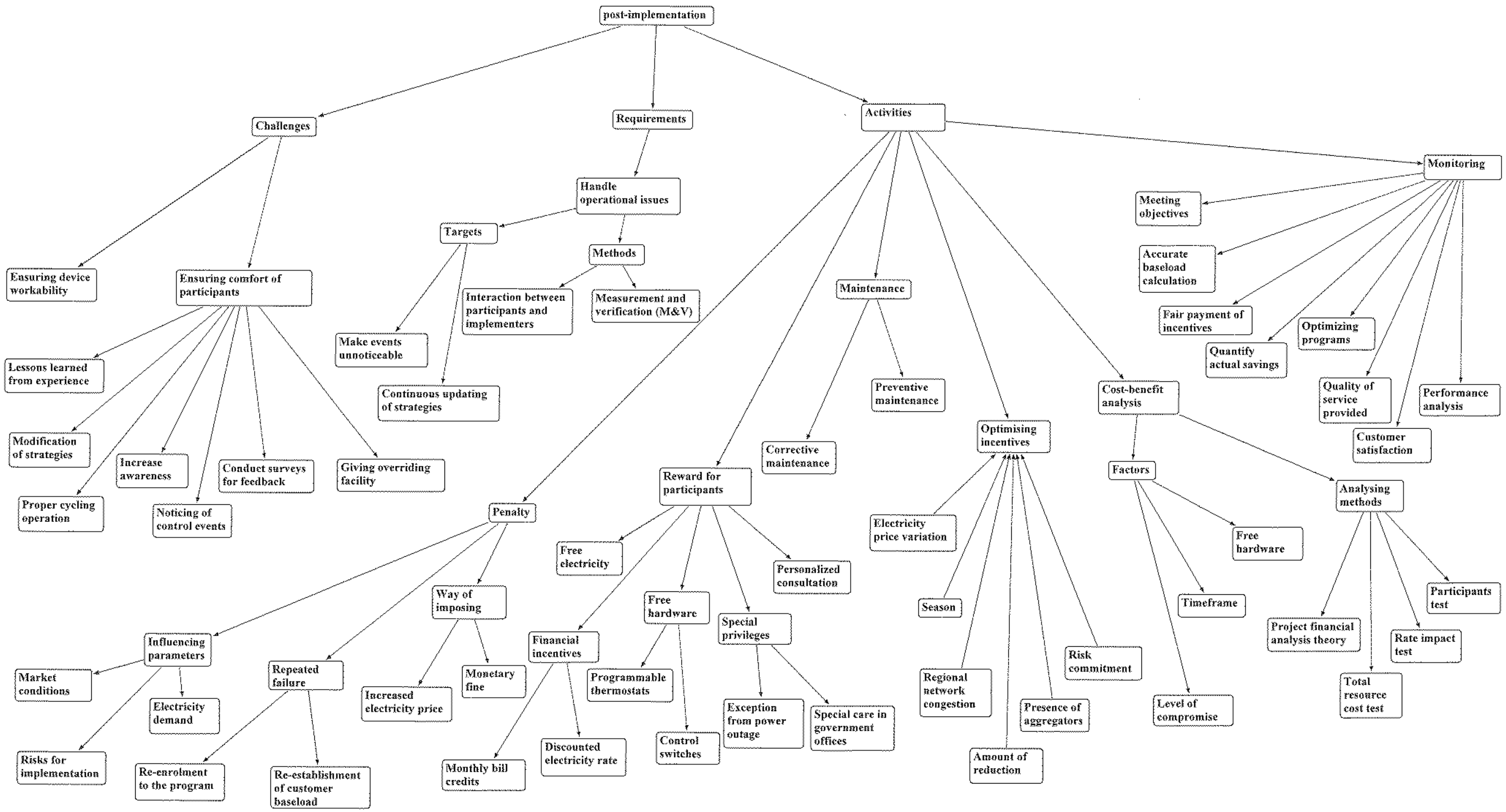
A11. Axial coding of pre-implementation phase



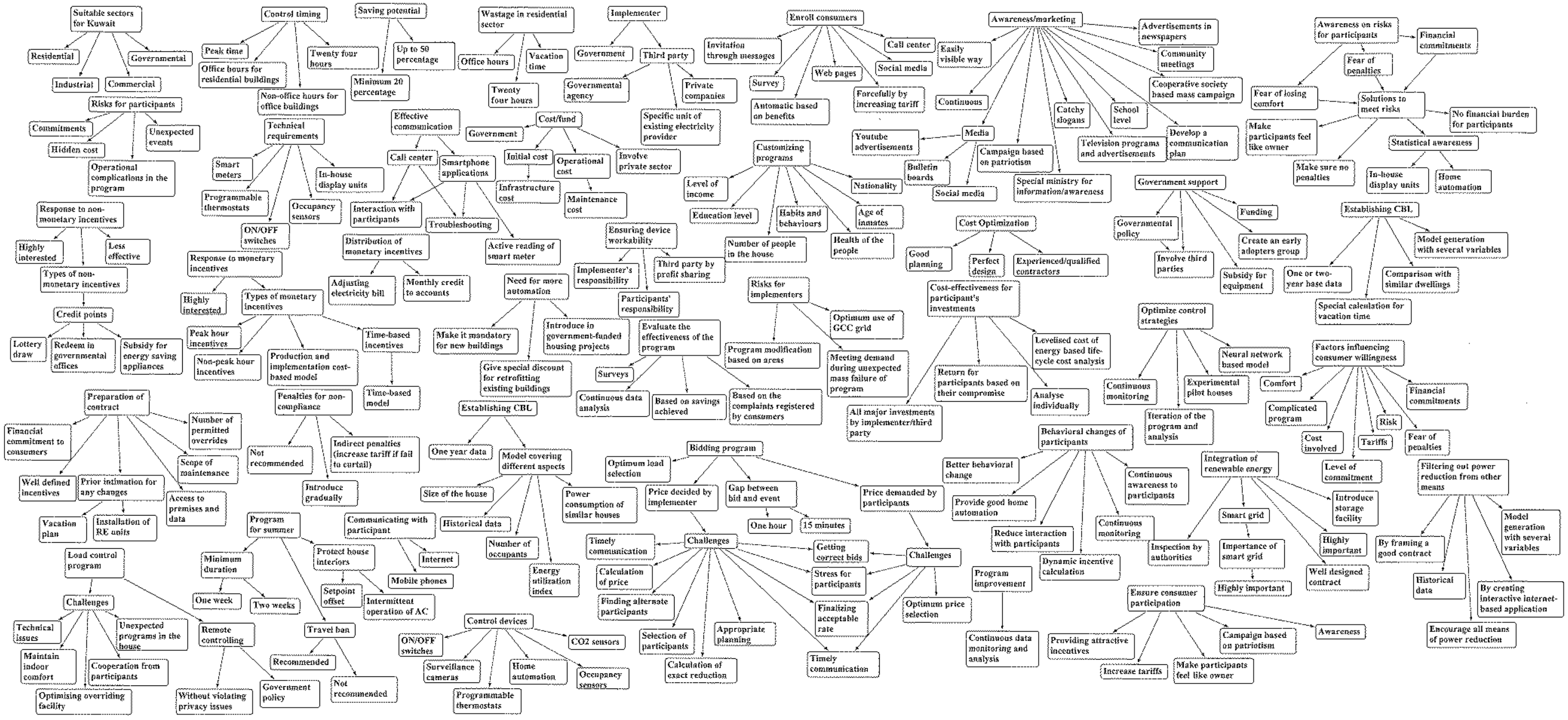
A12. Axial coding of implementation phase



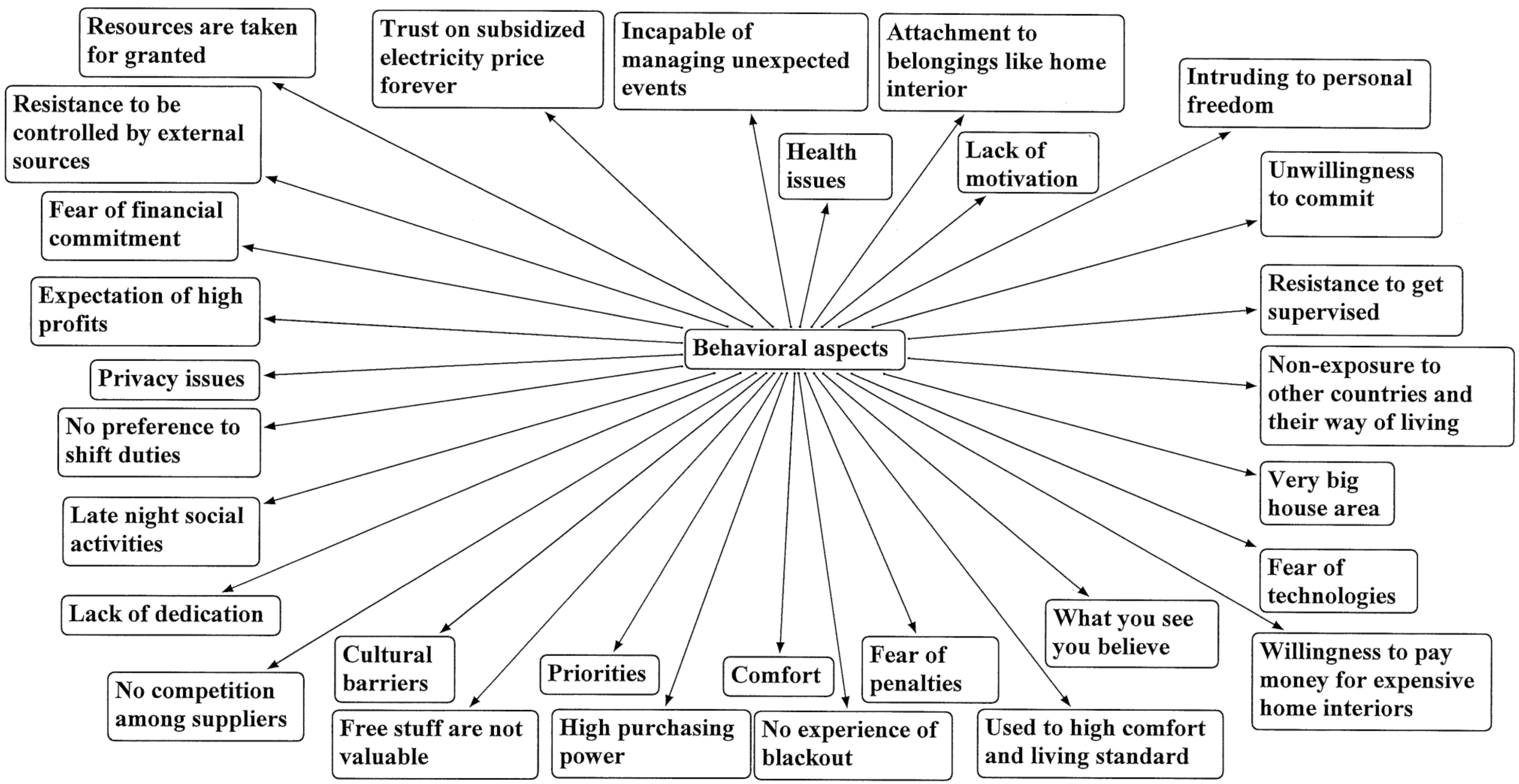
A13. Axial coding of post-implementation phase



A14. Axial coding of interview results



A15. Axial coding of theoretical premise



A16. Survey Questionnaire

UNIVERSITY OF PETROLEUM & ENERGY STUDIES DEHRADUN, INDIA.

Assessment of user's interest in participating in electricity consumption reduction programs
تقييم اهتمام المستخدم بالمشاركة في برامج خفض استهلاك الكهرباء

1. Introduction المقدمة

The increasing electricity demand in Kuwait is met by building new fossil fuel based power plants. In many countries, the growing demand is met by implementing incentive-based electricity conservation programs. These program offer various types of incentives to consumers for reducing their electricity consumption.

This survey is intended to identify the willingness of residents in Kuwait (consumers) to participate in three different incentive based demand response programs, formulated as part of my Ph.D work. Kindly note that all the information collected through this survey will be kept confidential and will be used for Ph.D related studies only. This survey has no relation with any of the ministries or agencies in Kuwait, including Ministry of Electricity and Water (MEW) and Kuwait Institute for Scientific Research (KISR).

Three different types of programs have been designed to meet the growing electricity demand, all with rewards for the participants. The proposed programs are:

- Remotely controlling selected loads for agreed time.
- Summer vacation program.
- Quick bidding program.

Some of the major assumptions considered while preparing the questionnaire are given below:

- All the incentives offered in the questionnaire are hypothetical and not part of actual plan.
- Power consumption will be monitored continuously by using smart electricity meters installed in consumer's house.
- Savings will be estimated according to the base load of the house, which is calculated based on different parameters such as historical consumption, size of the house, power demand in similar houses etc.
- Electricity company will provide all required technical support for carrying out load reduction according to consumer's choice.

Since your responses are essential for identifying the most preferred program and incentive scheme, kindly respond to all questions irrespective of your preference.

تم تلبية الطلب المتزايد على الكهرباء في الكويت من خلال بناء محطات جديدة للطاقة القائمة على الوقود الأحفوري.
في كثير من البلدان، كما يتم تلبية الطلب المتزايد من خلال تنفيذ برامج المحافظة على الطاقة القائمة على الحوافز،
ويقدم هذا البرنامج أنواعا مختلفة من الحوافز للمستهلكين مقابل التقليل من استهلاكهم للكهرباء
ويهدف هذا الاستبيان إلى تحديد رغبة المقيمين (المستهلكين) في الكويت في المشاركة في ثلاثة برامج مختلفة للحوافز على الطلب، وضعت كجزء من رسالة الدكتوراه الخاصة بي. يرجى العلم أن جميع المعلومات التي سيتم جمعها من خلال هذا الاستبيان سوف تبقى سرية وسوف تستخدم للدراسات ذات الصلة فقط. هذا الاستبيان ليس له أي علاقة مع أي من الوزارات أو الوكالات في الكويت، بما في ذلك وزارة الكهرباء والماء ومعهد الكويت للأبحاث العلمية
وقد تم تصميم ثلاثة أنواع مختلفة من البرامج لتلبية الطلب المتزايد على الكهرباء من خلال مكافأة المشاركين. البرامج المقترحة هي
التحكم عن بعد بالأحمال المختارة للوقت المتفق عليه
البرنامج الخاص بعطلة الصيف
برنامج المزايدة السريعة
وفيما يلي بعض الافتراضات الرئيسية التي تم النظر فيها أثناء إعداد الاستبيان
جميع الحوافز المقدمة في الاستبيان افتراضية و ليس جزء من الخطة المستقبلية
سيتم رصد استهلاك الطاقة بشكل متواصل باستخدام عدادات الكهرباء الذكية الموضوعة في منازل المستهلكين
سيتم تقدير التوفير وفقا للحمل الأساسي من المنزل، والذي يتم حسابه بناء على معايير مختلفة مثل التاريخ الاستهلاكي، مساحة المنزل ، والطلب على الطاقة في المنازل المماثلة، إلخ
ستقوم شركة الكهرباء بتوفير كل الدعم الفني اللازم لتنفيذ تخفيض الحمل وفقا لاختيار المستهلك
بما أن إجاباتكم بالغة الأهمية لتحديد البرنامج والحوافز الأكثر تفضيلا، يرجى الرد على جميع الأسئلة بغض النظر عن تفضيلاتك

UNIVERSITY OF PETROLEUM & ENERGY STUDIES
DEHRADUN, INDIA.

Assessment of user's interest in participating in electricity consumption reduction programs
تقييم اهتمام المستخدم بالمشاركة في برامج خفض استهلاك الكهرباء

2. General Information معلومات عامة

*** 1. Nationality الجنسية**

- ◯ Kuwaiti كويتي
- ◯ Non-Kuwaiti غير كويتي

*** 2. Age group الفئة العمرية**

- ◯ Below 30 أقل من
- ◯ 31 - 40
- ◯ 41 - 50
- ◯ 51 - 60
- ◯ 61 - 70
- ◯ Above 70 فوق

3. Profession المهنة

[ ]

*** 4. Location of house موقع المنزل**

- ◯ Al Asimah العاصمة
- ◯ Hawalli حولي
- ◯ Farwaniya الفروانية
- ◯ Mubarak Al-Kabeer مبارك الكبير
- ◯ Ahmadi الأحمدي
- ◯ Jahra الجهراء

*** 5. Type of building نوع المبنى**

- ◯ Own Villa فيلا خاصة
- ◯ Rented Villa فيلا مؤجرة
- ◯ Floor/Flat in a family Villa طابق / شقة في فيلا الأسرة
- ◯ Rented Floor in a Villa شقة مؤجرة / طابق في فيلا
- ◯ Rented Apartment/Flat شقة مؤجرة / شقة
- ◯ Own Apartment/flat تملك شقة / شقة

*** 6. Total number of rooms in the house (including kitchen and hall)**
إجمالي عدد الغرف في المنزل (مع المطبخ والصالة)

*** 7. Electricity bill paid by المكلف بدفع فاتورة الكهرباء**

- ◯ Yourself انت
- ◯ By building owner مالك المبنى

*** 8. Total Monthly income of the family إجمالي الدخل الشهري للأسرة**

- ◯ Less than KD 500 أقل من
- ◯ KD 2001 - 3000
- ◯ KD 501 - 1000
- ◯ KD 3001 - 4000
- ◯ KD 1001 - 2000
- ◯ Above KD 4000 أكثر من

*** 9. Total number of male adults residing in the house إجمالي عدد الذكور البالغين المقيمين في المنزل**

*** 10. Total number of female adults residing in the house إجمالي عدد الإناث البالغات المقيمات في المنزل**

*** 11. Total number of children residing in the house إجمالي عدد الأطفال المقيمين في المنزل**

*** 12. Do you have the capability to reduce electricity consumption without any expert's help?**
هل لديك القدرة على تقليل استهلاك الكهرباء دون أي مساعدة من الخبراء؟

- ◯ Yes نعم
- ◯ No لا

*** 13. Have you ever attended any electricity conservation awareness program?**
هل سبق لك حضور أي برنامج للتوعية بحفظ الكهرباء؟

- ◯ Yes نعم
- ◯ No لا

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3. Program 1: Remotely controlling selected loads for the agreed time period.

Program 1: Remotely controlling selected loads for agreed time period.

Highlights of the program:

- The electrical loads in the consumer's house will be remotely controlled based on the percentage and period agreed by the consumer.
- Special control devices will be installed for this purpose. With the help of these and based on the agreement with the consumer, AC units and other electrical appliances will be switched on/off, and/or temperature set points of AC units will be varied.

In return to load reduction, the following incentive schemes are offered.

البرنامج 1 : التحكم عن بُعد في الأحمال المحددة للفترة الزمنية المتفق عليها

الخطوط العريضة للبرنامج

سيقوم التحكم بالأحمال الكهربائية في منزل المشاركين عن بعد على أساس النسبة المئوية والفترة المتفق عليها من قبل المستخدم

وسيتم تركيب أجهزة التحكم الخاصة لهذا الغرض. مع مساعدة من هذه الأجهزة وبناء على اتفاق مع المستهلك، سيتم تشغيل وإطفاء وحدات التكييف وغيرها من الأجهزة الكهربائية وأو سيتم تغيير نقاط درجة الحرارة من وحدات تكييف الهواء

في مقابل تخفيض الحمل، سيتم تقديم الحوافز التالية

*** 14. Program 1: Remotely controlling selected loads for the agreed time period.**

البرنامج 1 : التحكم عن بُعد في الأحمال المحددة للفترة الزمنية المتفق عليها

1.1 Cash refund أسترجاع النقود

For each kWh reduction in the electricity consumption, receive 15 fils between 13:00 – 17:00 hrs and 10 fils for other time period.

لكل كيلووات ساعة من تخفيض استهلاك الكهرباء، سيتم الحصول على 15 فلس بين 13:00 حتي 17:00 و 10 فلس لفترة زمنية أخرى

Please choose your willingness to participate in the program for the given time period

يرجى اختيار مدى استعداداك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
04:00 to 06:00 (Early morning الصباح الباكر)	◯	◯	◯	◯	◯
06:00 to 08:00 (Morning الصباح)	◯	◯	◯	◯	◯
08:00 to 13:00 (Office time أوقات العمل)	◯	◯	◯	◯	◯
13:00 to 17:00 (Peak time وقت الذروة)	◯	◯	◯	◯	◯
17:00 to 22:00 (Evening المساء)	◯	◯	◯	◯	◯
22:00 to 04:00 (Night الليل)	◯	◯	◯	◯	◯

*** 15. Please choose your preferred percentage of load reduction against time frame**
يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75%يخفض	Reduce 76 to 100 % يخفض
04:00 to 06:00 (Early morning الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

*** 16. Program 1: Remotely controlling selected loads for agreed time period**
البرنامج 1 : التحكم عن بُعد في الأحمال المحددة للفترة الزمنية المتفق عليها

1.2 Credit points نقاط المكافئة

Once participants opt this scheme, they will get a membership in an elite club. Based on the time and percentage of reduction, points will be credited to their account. The more they reduce their loads, the more are the chances of getting points. There will also be extra points for reducing consumption during peak hours. These points can be redeemed for any of the following purposes.

في حال اختيار المشارك هذا البرنامج، سوف يحصل على عضوية النخبة. واستنادا إلى الوقت والنسبة المئوية للخفض، يتم تقييد النقاط. وكلما خفضت الأحمال، كلما زادت فرص الحصول على نقاط. و خلال ساعات الذروة تزيد النقاط, ثم يمكن استبدال هذه النقاط للحوافز كالآتي في حال اختيار المشارك هذا البرنامج، سوف يحصل على

- **Special counter for governmental services, airport immigration, car passing, etc.**
- **معاملة مميزة للخدمات الحكومية، هجرة المطار، مرور السيارات، الخ**
- **Entry to a daily, weekly, monthly and yearly lottery draw. Also, special recognition by electricity company when certain points are earned.**
- **الدخول في السحب اليومي والأسبوعي والشهري والسنوي. أيضا مميزات من قبل**

شركة الكهرباء عندما يتم كسب النقاط

- Special discounts for energy efficient appliances and solar panels.
- تخفيضات خاصة للأجهزة ذات الكفاءة العالية في المحافظة على الطاقة والألواح الشمسية

Please choose your willingness to participate in the program for the given time period
يرجى اختيار استعدادك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
04:00 to 06:00 (Early morning (الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time (أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

*** 17. Please choose your preferred percentage of load reduction against time frame**
يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75% يخفض	Reduce 76 to 100 % يخفض
04:00 to 06:00 (Early morning الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

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4. Program 2: Summer vacation plan خطة السفر في الصيف للقطاع السكني

*** 18. No. of weeks normally spent out of Kuwait during summer season? عدد الأسابيع الذي تقضيها في السفر في فصل الصيف؟**

- ◯ 0 week أسابيع
- ◯ 1 week اسبوع واحد
- ◯ 2 weeks اسبوعان
- ◯ 3 weeks أسابيع
- ◯ 4 weeks أسابيع
- ◯ 5 weeks أسابيع
- ◯ 6 weeks أسابيع
- ◯ 7 weeks أسابيع
- ◯ 8 weeks أسابيع
- ◯ More than 8 weeks أكثر من ٨ أسابيع

Program 2: Summer vacation plan for residential sector

<u>**Highlights of the program:**</u>

- Consumers to ensure the promised load reduction in their own suitable way.
- This program is meant for summer season (June to September) only.

In return to load reduction, the following incentive schemes are offered

البرنامج 2: خطة السفر في الصيف للقطاع السكني

<u>**مزايا البرنامج**</u>
يقدم ضمان للمستهلك بتخفيض الحمل الموعود بالطريقة المناسبة
بعض الاستراتيجيات الذي يمكن اعتمادها
ويهدف هذا البرنامج لموسم الصيف (يونيو - سبتمبر) فقط

في مقابل تخفيض الحمل، وتقدم الحوافز التالية

* 19. Program 2: Summer vacation plan for residential sector السفر في الصيف للقطاع السكني

2.1 Cash Refund: أسترجاع النقود

Receive a payback of 10 fils for reducing 1kWh of electricity during vacation period.

الحصول على استرداد 10 فلسا للحد من 1 كيلو وات ساعة من الكهرباء خلال فترة العطلة

Please choose your willingness to participate in the program for the given time period

يرجى اختيار استعدادك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
Up to 50 % of vacation time حتى ٥٠٪ من وقت السفر	○	○	○	○	○
51 to 90% of vacation time ٦١-٩٠٪ من وقت السفر	○	○	○	○	○
91 % and above of vacation time ٩١٪ وأكثر من وقت السفر	○	○	○	○	○

* 20. Please choose your preferred percentage of load reduction against time frame

يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75% يخفض	Reduce 76 to 100 % يخفض
Up to 50 % of vacation time حتى ٥٠٪ من وقت السفر	○	○	○	○	○
51 to 90% of vacation time ٦١-٩٠٪ من وقت السفر	○	○	○	○	○
91 % and above of vacation time ٩١٪ وأكثر من وقت السفر	○	○	○	○	○

*** 21. Program 2: Summer vacation plan for residential sector البرنامج 2: خطة السفر في الصيف للقطاع السكني**

2.2 Credit points نقاط المكافئة

Once participants opt this scheme, they will get a membership in an elite club. Based on the time and percentage of reduction, points will be credited to their account. The more they reduce their loads, the more are the chances of getting points. There will also be extra points for reducing consumption during peak hours. These points can be redeemed for any of the following purposes.

في حال اختيار المشارك هذا البرنامج، سوف يحصل على عضوية النخبة. واستنادا إلى الوقت والنسبة المئوية للخفض، يتم تقييد النقاط. وكلما خفضت الأحمال، كلما زادت فرص الحصول على نقاط. و خلال ساعات الذروة تزيد النقاط, ثم يمكن استبدال هذه النقاط للحوافز كالآتي

- **Special counter for governmental services, airport immigration, car passing, etc.**
- **معاملة مميزة للخدمات الحكومية، هجرة المطار، مرور السيارات، الخ**
- **Entry to a daily, weekly, monthly and yearly lottery draw. Also, special recognition by electricity company when certain points are earned.**
- **الدخول في السحب اليومي والأسبوعي والشهري والسنوي. أيضا مميزات من قبل شركة الكهرباء عندما يتم كسب النقاط**
- **Special discounts for energy efficient appliances and solar panels.**
- **تخفيضات خاصة للأجهزة ذات الكفاءة العالية في المحافظة على الطاقة والألواح الشمسية**

Please choose your willingness to participate in the program for the given time period يرجى اختيار استعدادك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
Up to 50 % of vacation time حتى ٥٠٪ من وقت السفر	○	○	○	○	○
51 to 90% of vacation time ٦١-٩٠٪ من وقت السفر	○	○	○	○	○
91 % and above of vacation time ٩١٪ وأكثر من وقت السفر	○	○	○	○	○

*** 22. Please choose your preferred percentage of load reduction against time frame**
يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75% يخفض	Reduce 76 to 100 % يخفض
Up to 50 % of vacation time حتى ٥٠٪ من وقت السفر	○	○	○	○	○
51 to 90% of vacation time ٦١-٩٠٪ من وقت السفر	○	○	○	○	○
91 % and above of vacation time ٩١٪ وأكثر من وقت السفر	○	○	○	○	○

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5. Program 3: Quick bid program البرنامج 3: برنامج المزاد السريع

Program 3: Quick bid program

This program is intended for quick power reduction based on the daily power forecast.

Highlights.

- On their website, Electricity Company will display the targeted load reduction at different hours of the day.
- Consumers to ensure the promised load reduction in their own suitable way

Incentives are calculated in two different ways

البرنامج 3: برنامج المزاد السريع

ويهدف هذا البرنامج بطريقة سريعة للحد من الطاقة على أساس توقعات الطاقة اليومية

مزايا البرنامج

في الموقع على شبكة الإنترنت، سيقوم شركة الكهرباء بعرض الحمل المستهدف ليتم تخفيضها في ساعات مختلفة من اليوم

يقدم ضمان للمستهلك بتخفيض الحمل الموعود بالطريقة المناسبة

وتحسب الحوافز بطريقتين مختلفتين

* 23. Program 3: Quick bid program البرنامج 3: برنامج المزاد السريع

3.1 Financial Incentive rate: Rates to be decided by electricity company

معدل الحوافز المالية: الأسعار التي يقررها شركة الكهرباء

Highlights of the program صفات البرنامج

- **Based on the willingness, consumers may submit their load reducing capability.**
- **بناء على الرغبة، يمكن للمستهلكين تقديم قابليتهم على الحد من الحمل**
- **Depending upon the number of responses, electricity company will decide the incentive rate and will inform the participants 15 minutes in advance to the agreed time.**
- **وتبعا لعدد الردود، ستقرر شركة الكهرباء معدل الحوافز وستبلغ المشاركين قبل 15 دقيقة من الموعد المتفق عليه**
- **If the rate is acceptable to consumers, they can participate, otherwise, decline.**
- **إذا كان المعدل مقبولا للمستهلكين، فيمكن المشاركة أو الإعتذار**

Please choose your willingness to participate in the program for the given time period

يرجى اختيار استعدادك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
04:00 to 06:00 (Early morning الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

*** 24. Please choose your preferred percentage of load reduction against time frame**
يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75% يخفض	Reduce 76 to 100 % يخفض
04:00 to 06:00 (Early morning الصباح الباكر)	◯	◯	◯	◯	◯
06:00 to 08:00 (Morning الصباح)	◯	◯	◯	◯	◯
08:00 to 13:00 (Office time أوقات العمل)	◯	◯	◯	◯	◯
13:00 to 17:00 (Peak time وقت الذروة)	◯	◯	◯	◯	◯
17:00 to 22:00 (Evening المساء)	◯	◯	◯	◯	◯
22:00 to 04:00 (Night الليل)	◯	◯	◯	◯	◯

*** 25. Program 3: Quick bid program البرنامج 3: برنامج المزاد السريع**

3.2 Financial Incentive rate: Rates demanded by participants

معدل الحوافز المالية: المعدلات التي يطلبها المشاركون

Highlights of the program صفات البرنامج

- **Based on the willingness, consumers may submit their load reducing capability along with expected incentive rates.**
- **بناء على الرغبة، يمكن للمستهلكين أن يقدموا القدرة على الحد من الحمل جنبا إلى جنب مع معدلات الحوافز المتوقعة**
- **Depending upon the number of responses, electricity company will decide and inform participants, whether the bid is accepted or not 15 minutes in advance.**
- **اعتمادا على عدد الردود، ستقوم شركة الكهرباء بإبلاغ المشاركين، سواء تم قبول العرض أو لا قبل 15 دقيقة**

Please choose your willingness to participate in the program for the given time period

يرجى اختيار استعدادك للمشاركة في البرنامج للفترة الزمنية المعينة

	Not at all interested غير مهتم على الإطلاق	Not interested غير مهتم	Not Sure غير متأكد	Interested مهتم	Highly interested مهتم جدا
04:00 to 06:00 (Early morning الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

*** 26. Please choose your preferred percentage of load reduction against time frame**
يرجى إختيار النسبة المئوية التي تفضلها للحد من الحمل مع الإطار الزمني

	0% Reduction تقليل	Reduce 1 to 25% يخفض	Reduce 26 to 50% يخفض	Reduce 51 to 75% يخفض	Reduce 76 to 100 % يخفض
04:00 to 06:00 (Early morning الصباح الباكر)	○	○	○	○	○
06:00 to 08:00 (Morning الصباح)	○	○	○	○	○
08:00 to 13:00 (Office time أوقات العمل)	○	○	○	○	○
13:00 to 17:00 (Peak time وقت الذروة)	○	○	○	○	○
17:00 to 22:00 (Evening المساء)	○	○	○	○	○
22:00 to 04:00 (Night الليل)	○	○	○	○	○

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6. General Feedback ردود الفعل العامة

*** 27.**
Kindly rate the programs according to your preference
يرجى تقييم البرامج وفقا لتفضيلاتك

	Not at all preferred غير مفضل على الإطلاق	Not preferred غير مفضل	Not Sure غير متأكد	Preferred مفضل	Highly preferred مفضلة للغاية
Remotely controlling selected loads for agreed time التحكم عن بعد بالأحمال المختارة للوقت المتفق عليه	◯	◯	◯	◯	◯
Summer vacation program البرنامج الخاص بعطلة الصيف	◯	◯	◯	◯	◯
Quick bidding program برنامج المزايدة السريعة	◯	◯	◯	◯	◯

*** 28. Do you agree upon making these type of programs mandatory in Kuwait?**
هل توافق على جعل هذا النوع من البرامج إلزاميا في الكويت؟

◯ Yes نعم ◯ No لا

*** 29.**

Kindly rate the incentive schemes according to your preference
يرجى تقييم خطط الحوافز وفقا لتفضيلاتك

	Not at all preferred غير مفضل على الإطلاق	Not preferred غير مفضل	Not Sure غير متأكد	Preferred مفضل	Highly preferred مفضلة للغاية
Cash refund أسترجاع النقود	○	○	○	○	○
Special service counters عدادات الخدمة الخاصة	○	○	○	○	○
Lottery draw and special recognition سحب و مميزات	○	○	○	○	○
Discount for efficient appliances and solar panels خصم للأجهزة ذات الكفاءة العالية والألواح الشمسية	○	○	○	○	○

30. Can you suggest any other ways to reward consumers for attracting them?
هل يمكنك اقتراح أي طرق أخرى لمكافأة المستهلكين لجذبهم؟

Thank you. شكراً لكم
Rajeev Alasseri (+965-66479210) راجيف الأسيري

A17. Coding of numerical values for the data collected from survey

Question no.	Focus area	Choices	Numerical Values
1	Nationality	Kuwaiti	1
		Non-Kuwaiti	2
2	Age group	Below 30	1
		31 to 40	2
		41 to 50	3
		51 to 60	4
		61 to 70	5
		Above 70	6
3	Profession	Technical	1
		Academic	2
		Sales	3
		Medical	4
		Management	5
		Finance	6
		Administrative	7
		Miscellaneous	8
4	Location of the house	Al Asimah	1
		Hawalli	2
		Farwaniya	3
		Mubarak Al-Kabeer	4
		Ahmadi	5
		Jahra	6
5	Type of Dwelling	Own Villa	1
		Floor/Flat in a family Villa	2
		Own Apartment/flat	3
		Rented Villa	4
		Rented Floor in a Villa	5
		Rented Apartment/Flat	6
6	Number of rooms	1 to 15	1 to 15
7	Payer of electricity bill	Self	1
		Owner	2
8	Monthly income	Less than KD 500	1
		KD 501 to 1000	2
		KD 1001 to 2000	3
		KD 2001 to 3000	4
		KD 3001 to 4000	5
		Above KD4000	6

9	Number of male adults	1 to 15	1 to 15
10	Number of female adults	1 to 15	1 to 15
11	Number of children	1 to 15	1 to 15
12	Capability for electricity reduction	Yes	1
		No	2
13	Attended electricity conservation program	Yes	1
		No	2
14,16,19, 21, 23, 25	Willingness	Not at all interested	1
		Not interested	2
		Not sure	3
		Interested	4
		Highly interested	5
15,17,20, 22, 24, 26	Possible load reduction	0%	1
		1 to 25%	2
		26 to 50 %	3
		51 to 75%	4
		76 to 100 %	5
18	Number of weeks out of Kuwait in a year	0 week	1
		1 week	2
		2 weeks	3
		3 weeks	4
		4 weeks	5
		5 weeks	6
		6 weeks	7
		7 weeks	8
		8 weeks	9
		More than 8 weeks	10
28, 29	Preference	Not at all preferred	1
		Not preferred	2
		Not sure	3
		Preferred	4
		Highly preferred	5

PROFILE OF THE AUTHOR

Rajeev Ramalloor Alasseri holds an MBA in Project Management from Sikkim Manipal University, India. After working in the field of industrial instrumentation and automation for eight years, he joined the energy department (now part of the Energy Efficiency Technologies Program under the Energy and Building Research Center) of the Kuwait Institute for Scientific Research (KISR) in 1999. He is a certified energy auditor and a LEED green associate.

During his tenure in KISR, he has been involved in various research projects, which are mainly focused on energy efficiency in the buildings. Some of the activities include energy auditing, development and implementation of energy and power saving schemes in residential and commercial buildings, optimization of water and energy consumption in cooling towers, photovoltaic assisted demand-side management in schools, improvement of indoor air quality in office buildings, LEED certification of buildings, etc.

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Alasseri, R., Rao, T. J., & Sreekanth, K. J. (2018). Conceptual framework for introducing incentive-based demand response programs for retail electricity markets. *Energy Strategy Reviews, 19*, 44–62. http://doi.org/10.1016/j.esr.2017.12.001.

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Articles under review:

Alasseri, R., Rao, T. J., & Sreekanth, K. J. Proposal for introducing incentive-based demand response programs for residential electricity sector. *Utilities Policy*, Submitted on 25 December 2017.

Alasseri, R., Rao, T. J., & Sreekanth, K. J. Pre-implementation assessment for introducing direct load control strategies in residential sector. *Sustainable Cities and Scociety*, Submitted on 20 March 2018.

Articles under review:

Title	**Authors**	**Jour-nal**	**Publi-sher**	**Manu-script number**	**Date of submis-sion**
Proposal for introducing incentive- based demand response programs for residential electricity sector	**Alasseri, R.**, Rao, T. J., & Sreekanth, K. J.	Utilities Policy	Elsevier	JUIP_2017_272	25 Dec 2017
Pre-implementation assessment for introducing direct load control strategies in residential sector.	**Alasseri, R.**, Rao, T. J., & Sreekanth, K. J.	Sustai-nable cities and society	Elsevier	SCS_2018_514	20 Mar 2018
Institution of incentive-based demand response programs and prospective policy assessments for a subsidized electricity market	**Alasseri, R.**, Rao, T. J., & Sreekanth, K. J.	Energy Policy	Elsevier	JEPO-D-18-01546	22 May 2018