Road Map for Smart Grid Implementation in Israel

November 2013

The Israeli Smart Energy Association

Authors and Contributors

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Mr. Lasker, the former President & CEO of the Israel Electric Corporation Ltd., is a seasoned business leader in the Hi-Tech and Energy space
Lasker's previous positions include CEO, Gilat Satcom; private promoter of telecom projects; Founder & CEO of the med Group; Founder & Managing Director of Globescom investments ltd.; Founder, President & CEO of Gvanim cable TV ltd. Managing Director of Keren electronics Ltd.; VP Marketing & Sales at Telrad Industries ltd. , and Finance division controller & Product Planning manager for Israel aircraft industries ltd.
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Chapter 7 – Industry Engagement
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Daniel holds a mechanical Engineers Bsc, from the Technion Israel
Since 2008, is acting, as the Energy and Infrastructure division general manager in General Engineers Company that is one of the major players, supplying power and grid equipment to the Israel Country.
Daniel, was in the past a design engineer in the Israel Electrical corporation dealing mainly with environmental protection equipment design.
Chapter 1 – SG Review and World Trends
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	**Dan Weinstock** **Dan** served as the Chief Electricity Engineer at Better Place, with responsibility for analysis, planning and implementation of charging and smart grid solutions. Prior to that, Dan served as the Director of the Electricity Administration in the Israeli Ministry of Energy and Water, and as the chief engineer of the light rail project of Tel Aviv. Dan is a published author and known expert, lecturer, and speaker in the field of smart grid, solar energy, energy optimization and deployment. **Chapter 2- Solutions, Technology and Road Map**
	**Emek Sadot** **Emek**'s expertise in Smart Grid and electric vehicle spans 5 years at Better Place as a senior director and head of energy services group, investigating Smart Grid managed platforms, smart charging, EV-roaming, utilities, batteries, charging systems and ancillary services. Prior to that position, Emek was CTO of Avaya USA, with responsibility for smart grid, wireless, and mobility. He has authored or co-authored more than 20 patents in the areas of electric vehicle managed platform, smart charging, electric consumption estimation and communications. **Chapter 2- Solutions, Technology and Road Map**

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Juliet Shavit is Head of the SmartMark Group, a family of companies that including SmartMark Communications, SmartEnergy IP, SmartShows, and SmartHoldings.
Juliet is a world-renowned expert on Smart Grid and the impact of customer experience on Smart Grid deployments. She enjoys applying lessons in communications convergence to help drive new business revenue models across multiple industries.

Chapter 3- The end-user as a Stake Holder</td></tr>
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Partner at ERM Law. Amnon’s practice is focused on finance, infrastructure and energy, and he heads the firm’s finance and projects practices.

Throughout his international and local career, Amnon has gained substantial experience acting for lenders, borrowers, debt issuers and credit enhancers on a full spectrum of international financing transactions and regulation.

In addition, Amnon has gained vast experience advising sponsors, lenders and EPC contractors in relation to complex projects in Israel and abroad, with specific expertise in infrastructure and energy.

Chapter 4- The legal aspects of SG deployment</td></tr>
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Dr. Ilan Suliman

16 years of experience in the public Energy sector. Ilan served as Deputy Chairman of the Israeli PUA (Public Utility Authority) until 2010. Since 2011 he is the founder and CEO of a consulting company focusing on Economics and Regulation of the Energy market.

Chapter 5 - Challenges and barriers and milestones for SG implementation in Israel

Gal Gonen

Gal has considerable experience in managing efficiency and cost reduction projects for corporations, performing business modeling and supervising and conducting tenders.

Gal is an expert in negotiation management, market analysis and business strategy development. Gal is a consultant for leading Israeli companies in diverse fields such as: health services, insurance, real-estate, infrastructure and technology, retail and venture capital initiatives.

Gal received both a B.A in economics and a M.B.A from Tel Aviv University.

Chapter 6 – Cost Benefit Analysis

Knut Haukenes

Knut Lytskjold Haukenes is currently a Masters student at London School of Economics in the field of International Political Economy. He is specializing in energy economics. Knut has two undergraduate degrees, one in Political Science and one in Economics, partially completed at the prestigious university of Sciences Po. in Paris. He has previously been working for Statoil, one of the world's leading energy companies.

Chapter 6 – Cost Benefit Analysis

Advisors:

	**Elad Shaviv** is the co-founder and serves as the CEO of the Israeli Smart Energy Association (ISEA). Mr. Shaviv is a seasoned business leader, currently engaged with both the Hi-Tech and Cleantech space and volunteers in several initiatives looking at possible initiatives to encourage investment at the Israeli cleantech industry. Mr. Shaviv has over 20 years of executive experience in the IT, telecoms and communications industries. Among his roles, Shaviv served as business executive at Cisco Europe, General Manager at Riverhead Networks, CEO of Forbase, and other executive roles including roles at the RAD Group, VCON and ECI Telecom.
	**Moty Gonen** Moty has more than 25 years of professional experience in the fields of corporate finance, performing business modeling and project valuations. Moty is an expert in founding and managing of finance systems, operations, computing and administration, capital raising, budgets and control. Moty took part in founding and financial managing of many corporations and venture capital initiatives and has enormous experience in leading and managing the financial part of large tenders such as: the second and third cellular tenders in Israel, The IEC fiber-optic cable tender in Israel, The postal office tenders and more. Moty received a B.A in economics and accounting from Tel Aviv University and is a certified C.P.A

	**Yackov Haimovitz** Mr. Haimovich has nearly 40 years of experience in finance and banking. Yaacov held various management positions at Bank Hapoalim including : Executive vice president as head of Asset Liability Management, director of the bank saving products department and manager of internal audit department.
	**Dan Bar Mashiah** Mr Bar Mashiah is the CEO and founder of ESCO Israel Energy Services. He is an economist and has a Master in Business Administration. In his former position as economic consultant to the CEO of the Israeli Ministry of Energy and Infrastructures, he has supervised the reform in the Fuel Sector and the national structure of the Natural Gas Sector

Samuel Neaman Institute

The Samuel Neaman Institute was established in 1978 in the Technion at Mr. Samuel Neaman's initiative. It is an independent multi-disciplinary national policy research institute. The activity of the institute is focused on issues in science and technology, education, economy and industry, physical infrastructure and social development which determine Israel's national resilience.

National policy research and surveys are executed at the Samuel Neaman Institute and their conclusions and recommendations serve the decision makers at various levels. The policy research is conducted by the faculty and staff of the Technion and scientists from other institutions in Israel and abroad and specialist from the industry.

The research team is chosen according to their professional qualifications and life achievements. In many cases the research is conducted by cooperation with governmental offices and in some cases at the initiative of the Samuel Neaman institute and without direct participation of governmental offices.

So far, the Samuel Neaman Institute has performed hundreds of exploratory national policy research projects and surveys that serve decision makers and professionals in economy and government. In particular the institute plays an important leading role in outlining Israel's national policies in science, technology and higher education.

Furthermore, the Institute supports national projects, such as the Ministry of Industry, Trade & Labor clusters - the MAGNET program in nano-technologies, media, optics and communication, chemistry, energy, environmental and social projects of national importance. The institute organizes also comprehensive seminars in its leading fields of research.

The Samuel Neaman Institute's various projects and activities can be viewed at the Institute website.

The chairman of Samuel Neaman Institute is professor Zehev Tadmor and the director is professor Omri Rand. The institute operates within the framework of a budget funded by Mr. Samuel Neaman in order to incorporate Israel's scientific technological economic and social advancement.

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1. Introduction

The Smart Grid is one of the main drivers of the future development of the world energy networks.

Most of the developed countries have set up quantitative targets and milestones for deployment until 2020 and 2030 and have allocated significant budgets for the implementation.

Israel is an "interesting case". On the one hand the Israel Electric Company (IEC) has installed advanced control and supervision systems in the transmission and distribution segments. On the other hand Israel is lagging behind in all elements related to the end user premises. The first trial is being performed these days and is scheduled to be completed during the first quarter of 2014.

The Israeli Smart Energy Association (ISEA) took upon itself to prepare a comprehensive document analyzing all aspects of the Enhanced Smart Meter deployment: Technology, Engineering, Regulation, Legal, Marketing, Economic (CBA) ,and role of the local industry.

This document analyzes the Smart Grid in an objective manner from the point of view of the national economy.

This paper was prepared by ISEA members on a voluntary basis. It was not financed by any stakeholder nor sponsored by any governmental or private entity.

What is Smart Grid?

Smart grid is a modernized electrical grid that uses information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

Smart Grid represents a new approach to meeting the needs of the new (power) world, where consumers will be able to interact with the power system for both consumption and generation through automated and intelligent control of their electrical appliances, thereby acting as resources for the power system.

Smart Grid objectives

The general objective is: To transform the electric grid to achieve sustainable energy future for the public good.
Smart grid goals may be classified by numerous different categories: On aggregate level (Global, National, Operators, and customers) and on functional level (Technical, operational and marketing). The Operational and Technical goals are mainly related to factors such as reliability, survivability, efficiency, security, resilience, improving asset utilization and operational efficiency, and have a direct impact on peak demand reduction, decrease of minutes of interruptions, integration of renewable, and reduction of greenhouse gas emissions.

The marketing goals have to do mainly with implementation of intelligent real time pricing, reduction of monthly bill payments by controlling electricity consumption and turning the typical energy customer from being passive to being active.

Each player has its own different preferences. The point of view of the operator is not necessarily matching to that of the customers, manufactures, service providers and so on**. This paper is trying to represent the national interest.**

The international experience

The world experience gained to date shows the trends and the variation of different ways of deploying the smart grid concept as a result of the specific needs and background of the grid before adopting the smart grid technologies.

It is clear that the smart grid is a fact. The question is not IF but WHEN and HOW.

The insight for the Israeli market:

First do a trial - Most countries perform technical and marketing trial before deploying the system worldwide.

Determine an adequate incentive to implement the smart grid technology- Common to all countries is the gap between the time the smart grid will show the real benefit and the period of investment. This phenomenon is called “CAPEX time-shift problem”. The key factor for success is introducing the right pricing that will motivate the end user to cooperate and save electricity.

2. Technology

Technology is an answer for a need, not an objective by itself.

Smart grid consists of many different technologies, appropriate to multiple disciplines, addressing two main segments:

1. The grid itself - This will include the following elements: Sensors, Connectivity, Communication, Security, Privacy, Real time, Data Sharing, Interfaces, Visualization and Operation
2. End consumers and small scale generation facilities.

The integration of all these components presents numerous Challenges:

Implementation, Integration, Cost, Standardization, Open platform, Acceptance (operators and customers).

The key success factor is looking at the following three aspects, and ensuring all are dealt with carefully: segmentation, benefits, and technology. Resulting in one integrated system that can serve all the network players.

3. The End user as a stakeholder - marketing aspects

In a smart grid environment, customers play a critical role in energy reduction, as they become more proactive in energy management. This calls for engagement between the utility and customers.

Smart grid offers a paradigm shift for a new model of customer communications. A model that moves from providing information only to providing education, and then to engagement.

Customers have a significant role to play in the new service delivery ecosystem. If customers do not engage with new tools and reduce energy use, the business case for smart grid is dissolved.

Israel has to implement the best practices that have helped utilities around the globe gather success:

Understand Stakeholder Engagement Internally - Customer advocacy groups, Strategic collaboration initiatives

Educate in Phases- Breaking down the elements of information and planning communications in phases as the deployment phases evolve

Understand the Customer - Market research plays a critical role in communications program design

Test the Messaging - Testing on different customer segments will result in more targeted and effective communications plan. People are different. Segments are different. Regions are different.

Monitor - Track response, Prepare to alter the plan and have contingencies

4. The legal aspect

Israeli law does not currently provide a specific set of rules or regulations dealing with the Smart Grid. Like in the case of many technological innovations, the legal system does not necessarily provide the tools to address this development.

It is recommended to examine general provisions of law related to the following:

Privacy – Since there is a high probability that the exposure of data collected by the smart meters will severely harm users' right to privacy, it is advisable to think of specific legislation which will clarify that a person has a right to request the operator to disclose the information gathered about him (whether in crude or in analyzed form) to third parties who should bear the costs associated therewith.

Ownership of the information - The main questions are:

- To whom does the gathered information belong – to the operator or to the customer?
- Does the customer have the right to request the operator to transfer the information relating to it (whether in an analyzed form or in its original form) to a third party without any compensation?

The answers to such questions are not entirely clear and involve various areas of law, and it is therefore advisable that the legislator specifically address this matter.

Antitrust - In order to ensure the maximization of the efficiency of the Smart Grid, it is highly important to apply the essential facility doctrine and to consider the Smart Grid's operator as a monopoly, so:

- The operator will be prohibited from discriminating between various electricity producers and supplier; and
- The market will be open to offer consumers various tools to efficiently use electricity and reduce their bills.

Consumer protection - The customers of the Smart Grid are also end-consumers, which means that the Consumer Protection Law will apply to the relationship between the consumers and the service provider. The type of regulation which has to be implemented should ensure that the consumer:

- Will receive and understand in advance the various options and related rates.
- Will receive clear information about all the alternatives
- Will have the ability to easily understand their bills.

5. Milestones for smart grid implementation

In developing any large-scale, infrastructure-intensive field, it is necessary to set clear, measurable milestones. .

The challenges involved in implementing smart grid in Israel are partially unique to Israel but most of them are internationally common. These are the most important:

1. **Regulators consent** - Setting agreed upon policy among regulators regarding goals and means. Coordination among all direct regulators of the electricity market is a must.
2. **Defining the implementing party** - Defining the role of IEC and the private sector ensuring legal access to SG data.
3. Defining priorities - Setting priorities with the purpose of integrating different interests of the stakeholders, as well as presenting a clear picture of the final SG

network. Smart grid should be an integral part in the National Energy Master Plan

4. **Data policy** - Determining rules to ensure open access as well as data confidentiality and security.
5. **Customer awareness** - Taking all necessary steps to build consumer trust. With the purpose of transforming the customers from being passive to assuming an active role in managing supply-side resources
6. **Technical solution**- Synchronizing and coordinating all the technical components being installed.
7. **Tariff** - Setting up an updated and flexible tariff policy.

Other recommendations:

1. **Expertise** - Identifying and enhancing areas of expertise currently found in Israel and leveraging that expertise.
2. **Funding** - Establishment of dedicated funds through electricity rates and/or Government budgets directed toward incentivizing promising smart grid development initiatives, including incubators to initiate new projects and technologies.
3. **Proven models** - Use of proven models from other countries in implementing cost-benefit analyses, until a significant wide trial will be executed.

6. Cost Benefit Analysis for Israel – Enhanced smart metering deployment

Mission statement

The aim of this report is to facilitate an informed investment decision for enhanced smart metering in Israel. The report serves this purpose by providing a coherent assessment of the quantifiable costs and benefits related to a nation-wide enhanced smart metering deployment in Israel. The use of the term enhanced points to the content of the entire system, specifically (1) smart meters, (2) communication components enabling real time, two ways communication the consumer and the infrastructure, (3) support software systems including billing system, (4) use of feedback enabling technology and (5) new and advanced tariff systems that embeds the potential of consumption pattern changes. With nation-wide deployment we understand (1) the household sector and (2) the small-to-medium enterprises (SME), a total of 2.54 million meter-points at the assumed start of the CBA (01.01.2015).

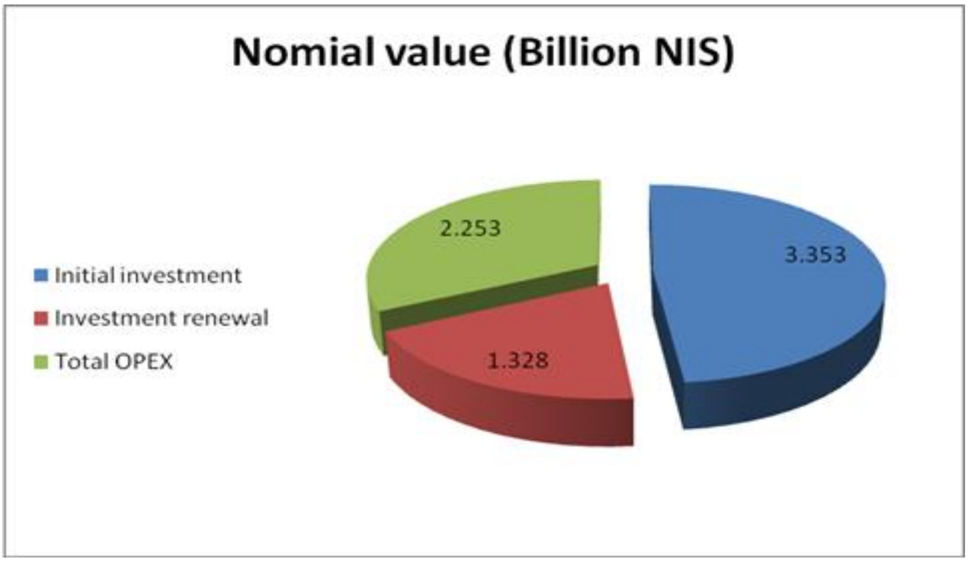
Macro assumptions and methodology

In the current report we assess (a) the incremental costs and benefits of enhanced smart metering from (b) a national point of view. An incremental analysis implies that all the costs of the business-as-usual scenario (BaU) over the horizon of the CBA will be subtracted from the costs of the enhanced smart metering deployment scenario. A national reference point implies that we calculate to what extent an investment in enhanced smart metering increases total social welfare (the size of the pie), with no reference paid to the issue of how this welfare gain is distributed (the size of each slice). To conduct the actual assessment, in lack of Israeli data, we have benchmarked costs and benefits against 20 national CBAs and more than 70 reports and research articles on pilots, technology trials and smart metering in general.

Costs of enhanced smart metering

In nominal value, the total costs of an enhanced smart metering deployment are 6.934 Billion NIS. Figure 1 displays a high level of these costs, divided into CAPEX and OPEX. Total CAPEX of enhanced smart metering is 4.681 billion NIS, sub-divided into (a) initial investment (3.353 billion NIS) and (b) investment renewal (1.328 billion NIS). Smart meters and communication is the most significant post internally (46%). Total OPEX of enhanced smart metering is 2.253 billion NIS, with data transmission as the most significant post internally (48%). CAPEX is more significant than OPEX since it includes both (a) the initial investment (3.353 billion) and (b) renewal investments (1.328 billion).

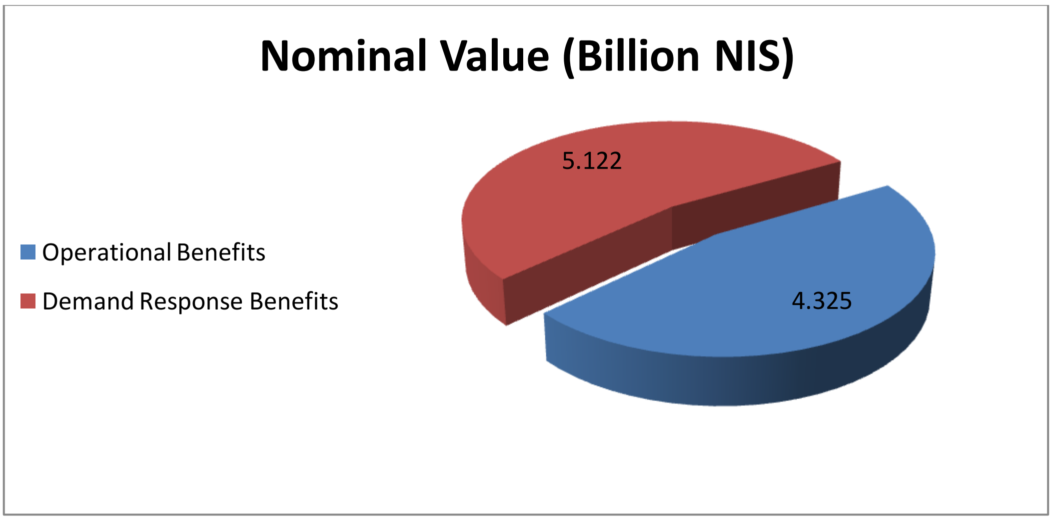
Figure 1: High level overview of CAPEX and OPEX



Benefits of enhanced smart metering

The total benefits of enhanced smart metering are 9.447 billion NIS. Figure 2 displays a high level of these benefits divided into Operational Benefits and Demand Response Benefits. Total Operational Benefits of enhanced smart metering are 4.325 billion NIS, with information benefits as the most significant post internally (47%). Total Demand Response Benefits of enhanced smart metering are 5.122 billion NIS, with consumption reduction as the most significant post internally (51%).

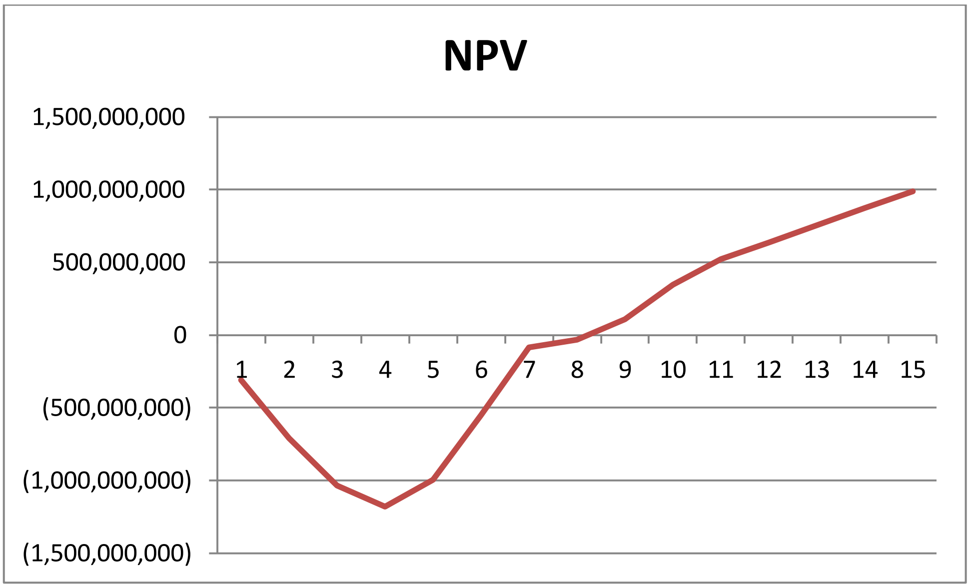
Figure 2: High level overview of Benefits



Main results

Over the 15 years time horizon of this CBA, enhanced smart metering deployment in Israel has a net benefit of 986.73 million NIS. Figure 3 displays how this NPV develops in time given the discount rate of seven percent. After the Initial IT CAPEX (407 million NIS) is completed after three and a half years, NPV shows a constant positive slope. In the fifth year there is a kink in the graph resulting from the deferring investments of a new power plant[1]. In the ninth year we get the first positive NPV.

Figure 3: NPV 2015-2030 given discount rate of 7%

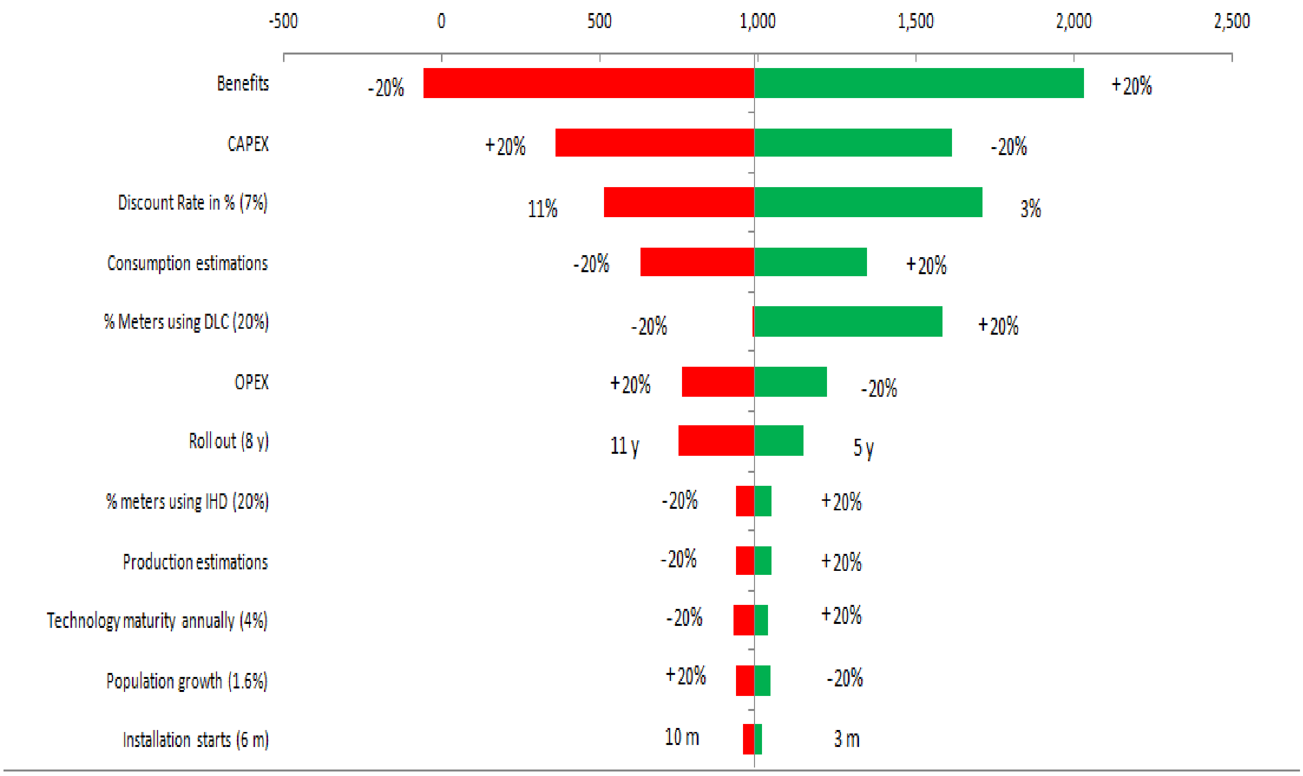


Sensitivity analysis.

From figure 4 we see that the NPV is most sensitive to changes in (1) benefits, (2) CAPEX, (3) discount rate and (4) consumption estimations. The positive NPV remains robust across a range of sensitivity tests carried out. A reduction in benefits of 20% is the single parameter with a potential of turning the NPV marginally negative. It is worth noting that the NPV would still be highly positive should the CAPEX of enhanced smart metering be 20% higher than what we assumed.

[1] The benefit is spread over three years with a 20%, 40% and 40% distribution respectively.

Figure 4: Sensitivity Analysis, changes in NPV



7. The Israeli industry engagement

The global focus on cleaner energy and energy efficiency has become a key driver for smart grid which is an integration of the Energy and Telecommunication systems. This turns SG to be a perfect solution for the evolution of the high tech industry.

The Israeli high – tech and electronic industry has more than 2000 companies who can provide services and products to the smart grid project, leveraging the country's strong base in semiconductors, power electronics, communications,

The industry has to take action and to learn:

- The specific requirements of the energy system.
- The international standards ,
- The current available products ,
- The profiles of energy customers and their market needs
- The business advantage combined with risk analysis.

Based on the results each company can:

- Analyze the profitability of adapting its product line to the Energy sector.
- Establishing the local operation.
- Recruit the funding by VC or others.
- Go international.

תקציר מנהלים

1. מבוא

הרשת החכמה היא אחד המרכיבים העיקריים בהתפתחות העתידית של רשתות האנרגיה בעולם. רוב המדינות המפותחות כבר הגדירו יעדים כמותיים ואבני דרך לפריסה של רשת חכמה עד שנת 2020 או 2030 והקצו תקציבים משמעותיים לצורך יישומה.
ישראל היא" מקרה מעניין " .מחד גיסא, חברת החשמל לישראל (חח"י) התקינה מערכות בקרה ופיקוח מתקדמות במקטעי ההולכה והחלוקה . מאידך גיסא ישראל מפגרת בכל האלמנטים הקשורים בתחום משתמשי הקצה . הפיילוט הראשון מתבצע בימים אלה והוא אמור להסתיים ברבעון הראשון של 2014.
האיגוד הישראלי לאנרגיה חכמה (ISEA) נטל על עצמו הכנת מסמך מקיף לניתוח כל ההיבטים של פריסת מערכת מונים חכמים משודרגת: טכנולוגיה , הנדסה , רגולציה, משפט , שיווק , כלכלה (CBA) ומעורבות התעשייה המקומית.
מסמך זה מנתח את הרשת החכמה באופן אובייקטיבי מנקודת מבטו של המשק הלאומי .
המסמך הוכן על ידי חברי ISEA על בסיס התנדבותי, ולא מומן על ידי בעלי עניין ולא על ידי כל גוף ממשלתי או פרטי.

מהי רשת חשמל חכמה ?

רשת חכמה היא רשת חשמל מודרנית המשתמשת בטכנולוגיית מידע ותקשורת דו-כוונית לאיסוף מידע על ההתנהגויות של צרכנים וספקי אנרגיה , ופועלת ומגיבה על בסיס מידע זה באורח אוטומטי כדי לשפר את היעילות , האמינות , הכלכליות, והקיימות של ייצור וחלוקת החשמל . Smart Grid מייצג גישה חדשה למתן מענה לצרכי החשמל של העולם החדש, עולם שבו צרכנים יהיו מסוגלים לתקשר עם מערכת החשמל בכל הנוגע לצריכה ולייצור באמצעות שליטה אוטומטית ואינטליגנטית במתקני ומכשירי החשמל. בכך הצרכן משמש כמשאב עבור מערכת החשמל ,והופך להיות מצרכן פאסיבי לצרכן אקטיבי.

מטרות רשת חכמה

מטרת העל היא לשנות ולחדש את רשת החשמל במטרה להשיג עתיד אנרגטי בר קיימא לטובת הציבור.
מטרות רשת חכמה ניתנות לסיווג לפי קטגוריות ורמות שונות: ברמה המצרפית (גלובלית , לאומית, מפעילים ,ולקוחות)וברמה התפקודית (טכנית, תפעולית ושיווקית) . המטרות התפעוליות והטכניות קשורות בעיקר לגורמים כגון אמינות, שרידות, בטיחות, שיפור בניצול משאבים ויעילות תפעולית .כל זה מתבטא בהשפעה ישירה על הפחתת שיאי ביקוש, ירידה בשיעור של דקות אי אספקה , כמו גם בשילוב של אנרגיה ממקורות מתחדשים והפחתת פליטות גזי חממה.

המטרות השיווקיות קשורות בעיקר עם יישום אינטליגנטי של תעריפי עומס וזמן, שיביא לירידה ריאלית בתשלומי חשבונות החשמל החודשיים. הרשת הופכת את צרכן האנרגיה הטיפוסי לצרכן חכם השולט על מרכיב ההוצאה האישית שלו לאנרגיה.

לכל שחקן יש העדפות שונות משלו . נקודת מבטו של **המפעיל** אינה בהכרח תואמת את זו של הלקוחות , יצרני האנרגיה, ספקי השירות וכן הלאה.

מסמך זה מנסה לייצג את האינטרס הלאומי.

הניסיון הבינלאומי

הניסיון בעולם שנצבר עד כה מציג את המגמות השונות ואת מגוון הדרכים לפריסת הרשת החכמה בהתאם למצב הרשת ולצרכיה בכל מדינה.

המסקנה החד – משמעית היא שהרשת החכמה היא עובדה. השאלה היא לא האם, אלא מתי ואיך.

1. תובנות לשוק הישראלי :

שלבי בצוע – השלב הראשון ביישום הוא ביצוע ניסוי (פיילוט). רוב המדינות ברחבי העולם ביצעו ניסוי טכני ושיווקי לפני פריסת המערכת, ועל בסיס תוצאותיו עברו לשלבים הבאים.

מערכת תעריפים תומכת – גורם המפתח להצלחה הוא תמחור נכון שיניע את משתמש הקצה לשתף פעולה ולחסוך בחשמל. לשם כך יש לקבוע מערכת תעריפים חכמה הכוללת תמריצים משמעותיים ללקוח , ובנויה כך שתוכל ללמוד ולהגיב במהירות בהתאם להתנהגות המשתמשים.

בעיה משותפת שזוהתה בכל המדינות היא הפער בין תקופת ההשקעה ובין המועד בו תניב הרשת החכמה תועלות כמותיות. הפיתרון נעוץ ביצירת קואליציה בה משולבים כל ה"שחקנים" – הרגולטור, המפעילים, הצרכנים וספקי הציוד והשירותים שתבנה תוכנית מימון לגישור על פערי הזמן.

2 . טכנולוגיה

טכנולוגיה היא תשובה לצורך, ולא מטרה בפני עצמה.
רשת חכמה מורכבת מטכנולוגיות שונות, המגיעות מדיסציפלינות שונות. ומתפלגות בין שני ענפים עיקריים :

1 . הרשת עצמה - הרשת כוללת את הרכיבים הבאים : חיישנים , קישוריות, תקשורת, אבטחה, פרטיות, זמן אמת, שיתוף נתונים, ממשקים, הדמיה והפעלה.

2 . יחידות הקצה - צרכני קצה ומתקני ייצור בקנה מידה קטנים .

שילוב כל המרכיבים הללו מציב אתגר אינטגרטיבי הכולל: יישום, אינטגרציה, עלות, תקינה , פלטפורמה פתוחה , וקבלה (מפעילים ולקוחות) זהו תנאי מוקדם ליצירת מערכת משולבת אחת שתוכל לשמש ולשרת את כל השחקנים ברשת.

3 . ההיבטים השיווקיים

רשת חכמה הופכת את הלקוחות לשחקן מרכזי בהפחתת צריכת אנרגיה , ככל שהם יותר פעילים בניהולה. עובדה זאת מובילה להתקשרות שונה בין נותן השירות והלקוחות.
רשת חכמה מציעה שינוי פרדיגמה ובניית מודל חדש של תקשורת עם לקוחות .

מודל שעובר ממסירת מידע בלבד למודל של הדרכה, חינוך , ושיתוף פעולה עם הלקוחות. ללקוחות יש תפקיד משמעותי. ככל שהם ישתמשו בכלים החדשים על מנת להפחית את השימוש באנרגיה, כך ההצדקה העסקית כלכלית של הרשת החכמה תקבל ביסוס וחיזוק.. **ההמלצה האופרטיבית היא שישראל תיישם את שיטות העבודה המומלצות שעזרו לנותני מפעילי השירות ברחבי העולם להגיע להצלחה :**

להבין את בעלי העניין השונים- קבוצות תמיכת לקוחות , יוזמות שיתוף פעולה אסטרטגיות
להבין את הלקוח - מחקר שוק מהווה מרכיב קריטי בעיצוב תכנית תקשורת.
לחנך שלב שלב - פירוק מרכיבי המידע והתקשורת לפי שלבי פריסת המערכת.
לבחון את המסרים – בדיקה במגזרי לקוחות שונים תגרום לתכנית תקשורת יותר ממוקדת ויעילה. אנשים, מגזרים ואזורים שונים זה מזה ומחייבים התייחסות פרטנית.
מעקב – מעקב אחר תגובתיות, מוכנות לשנות את התכנית ויישום תכנית חלופית.

4 . ההיבט המשפטי

כללי

הדין הישראלי אינו נותן כיום מענה ישיר לסוגית הרשת החכמה. כאשר יידרשו בתי המשפט להתמודד עם סוגיות העלות מהקמת והפעלת הרשת החכמה יש להניח שבתי המשפט ייפנו למערכות הדינים הכלליות החלות היום (כגון פרטיות, דיני הגנת הצרכן וההגבלים העסקיים) ובמקרה הצורך גם ייפנו לדין האמריקאי והאירופאי בכדי לבחון איך דינים אלו מטפלים בנושא. במקביל לכך יש להניח שהמחוקק ישקול את הצורך בחקיקה ספציפית מתאימה בין מיוזמתו ובין כתוצאה מפנייה של בעלי עניין.

הדינים שיש להניח שבתי המשפט הישראלים יחילו לענייננו הינם:

פרטיות

הרשת החכמה תפיק כמויות רבות של מידע צרכני הכולל וריאציות שונות של נתוני צריכת חשמל, שיאוחסן במאגר מידע דיגיטאלי. המידע הרגיש עשוי לשמש למעקב אחר צרכנים על-ידי גופים שונים כאלו שפועלים כחלק מהרשת החכמה ואף גופים שאינם קשורים לתפעולה של הרשת, שלהם אינטרס כלכלי בגישה למידע. בנוסף, כיוון שחשיפה של הנתונים שנאספו על ידי המונים החכמים תפגע בזכות לפרטיות של המשתמשים , רצוי לחשוב על חקיקה שתבהיר כי לאדם יש זכות לבקש מהמפעיל לחשוף את המידע שנאסף עליו (בין המידע הגולמי או המנותח).

קניין

שאלות עקרוניות העולות הינן:

• למי שייך המידע שנאסף - למפעיל או לצרכן?
• האם יש ללקוח את הזכות לבקש מהמפעיל להעביר את המידע המתייחס אליו לצד שלישי, ללא כל שיפוי?

גם כאן הדין הקיים אינו נותן מענה והיה רצוי שהמחוקק יחווה דעתו בעניין.

הגבלים עסקיים

ייתכן שייקבע שהרשת החכמה הינה "משאב חיוני" אם יקבע שאיננה ניתנת לשכפול וחיונית לשם התחרות. במקרה כזה יחויב בעל הרשת לאפשר גישה לכל המשתמשים הרלוונטיים.

דוקטרינת המשאב החיוני פותחה במשפט המשווה כדי שניתן יהיה לחייב בעל מונופולין, בנסיבות מסוימות, לאפשר שימוש בנכס או במתקן מונופולי גם לאחרים זולתו, לרבות מתחרים של בעל המונופולין וזאת על מנת לעודד את התחרות באותו ענף בו פועל המונופולין.

הגנת הצרכן

משתמשי הרשת החכמה יהיו גם צרכני קצה, על כן ישנה תחולה גם לחוק הגנת הצרכן. חוק הגנת הצרכן כולל הסדרים ספציפיים לגבי שירותים ספציפיים וייתכן ויהיה צורך בהסדרה רגולטורית המיועדת להתמודד ישירות עם היבטים צרכניים שינבעו מפעילות הרשת החכמה.

על המחוקק להבטיח כי הצרכן:

•יקבל מראש ויבין את אפשרויות התעריפים השונים העומדות בפניו.

•יקבל מידע ברור על כל החלופות

• יוכל להבין את החשבונות בקלות

5 . אבני דרך ליישום רשת חכמה

רשת חכמה מהווה פרויקט תשתית בקנה מידה גדול, וככזה יש צורך לקבוע אבני דרך ברורות, הניתנות למדידה .

האתגרים הכרוכים ביישום רשת חכמה בישראל הם באופן חלקי ייחודיים לישראל , אך רובם משותפים לכל העולם. החשובים ביותר הם:

1 . הסכמת הרגולטורים – הגדרת מדיניות מוסכמת בין הרגולטורים לגבי מטרות ואמצעים . תיאום בין כל הרגולטורים הישירים של שוק החשמל הוא חובה.

2 . הגדרת הגוף המיישם – הגדרת התפקיד של חברת החשמל והמגזר הפרטי הבטחת גישה חוקית לנתוני הרשת החכמה.

3 . **הגדרת סדרי עדיפויות** - קביעת סדר עדיפויות במטרה לשלב האינטרסים של בעלי העניין השונים , כמו גם בהצגת תמונה ברורה של הקונפיגורציה הסופית של הרשת. רשת חכמה צריכה להיות חלק בלתי נפרד מתכנית האב הלאומית לאנרגיה

4 . **מדיניות ניהול נתונים** - קביעת כללים להבטחת גישה פתוחה , כמו גם שמירה על סודיות ואבטחת מידע.

5 . מודעות של לקוחות – יש לבצע את כל הצעדים הדרושים כדי לבנות את אמון הצרכן. במטרה להפוך את הלקוח מלהיות פסיבי לבעל תפקיד פעיל בניהול משאב זה

6 . פתרון טכני - סנכרון ותיאום כל המרכיבים הטכניים שמותקנים.

7 . תעריף – הגדרת מדיניות תעריפים מעודכנת וגמישה להיזונים חוזרים.

המלצות נוספות :

1 . **מומחיות** - זיהוי ושיפור תחומי ההתמחות הנמצאים כיום בישראל ומינופם.
2 . **מימון** - הקמת קרנות ייעודיות באמצעות תעריפי חשמל או תקציבים ממשלתיים המכוונים לכיוון תמריצים עבור יוזמות פיתוח מבטיחות בתחום כולל חממות ליזום פרויקטים חדשים וטכנולוגיות חשמל.
3 . **מודלים מוכחים** - שימוש במודלים מוכחים ממדינות אחרות ביישום ניתוחי עלות תועלת , עד אשר יתבצע ניסוי רחב ומשמעותי .

6. ניתוח עלות-תועלת CBA

מטרת העבודה

מטרת עבודה זו הינה לסייע בקבלת החלטת השקעה מושכלת בדבר פריסת מערכת מונים חכמים "מועשרים" בישראל. דוח זה ממלא את מטרתו על ידי הכנת מודל עלות-תועלת אובייקטיבי מנקודת ראות של המשק הלאומי, במטרה לבחון האם קיימת הצדקה כלכלית לפריסת מונים חכמים בישראל. ניתוח עלות-תועלת, Cost Benefit Analysis נעשה תוך מתן אומדן קוהרנטי לעלויות והתועלות הניתנות לכימות בלבד.

השימוש במונח "מועשר" מצביע על תכולת המערכת הכוללת: (1) מונים חכמים, (2) מערכת תקשורת דו כיוונית בזמן אמיתי בין הצרכן והתשתיות ומרכזי הבקרה והשירות, (3) מערכות תוכנה תומכות לרבות מערכת גביה, (4) שימוש בטכנולוגיות המאפשרות משוב ("Feedback") אקטיבי מן הצרכן, (5) מבני תעריפים מתקדמים וחדשניים המאפשרים לגלם את הפוטנציאל של שינוי בדפוסי הצריכה.

כאשר אנו מתייחסים לפריסה כלל ארצית, אנו בוחנים (1) משקי הבית, (2) עסקים קטנים וחברות בינוניות (Small-Medium enterprise). אוכלוסיה זו צפויה לכלול כ – 2.54 מליון מונים בנקודת הזמן המוערכת לתחילת המודל, 1.1.2015.

הנחות מאקרו ומתודולוגיה

במסגרת עבודה זו אנו בוחנים (א) עלויות ותועלות תוספתיות (Marginal) ביחס למצב הקיים ("Business as usual") (ב) מנקודת מבט לאומית. משמעות ניתוח עלויות ותועלות תוספתיות הינה: (א) כל עלויות המצב הקיים לאורך משך החיים של המודל יופחתו מן העלויות של פריסת המונים החכמים. (ב) עלויות נמנעות יחשבו כתועלות. משמעות הניתוח מנקודת מבט לאומית הינה שאנו מחשבים את מידת ההשפעה של פריסת מונים חכמים בישראל על הרווחה הכוללת של האוכלוסיה (כלומר, השינוי בגודל העוגה). אנו לא מתייחסים לנושאים כגון אופן חלוקת הרווח או צדק חלוקתי.

בשל מחסור במקורות מידע מישראל וכדי לבצע אומדן קרוב ככל הניתן, ביצענו בחני ביצועים ("Benchmarks") המבוססים על 20 ניתוחי עלות-תועלת ולמעלה מ – 70 דוחות ומחקרים הנוגעים לפיילוטים, בחינות טכנולוגיות ופריסת מונים חכמים באופן כללי. התבססנו על מידע ונתונים מקומיים היכן שקיימים.

עלויות פריסת מונים חכמים "מועשרים"

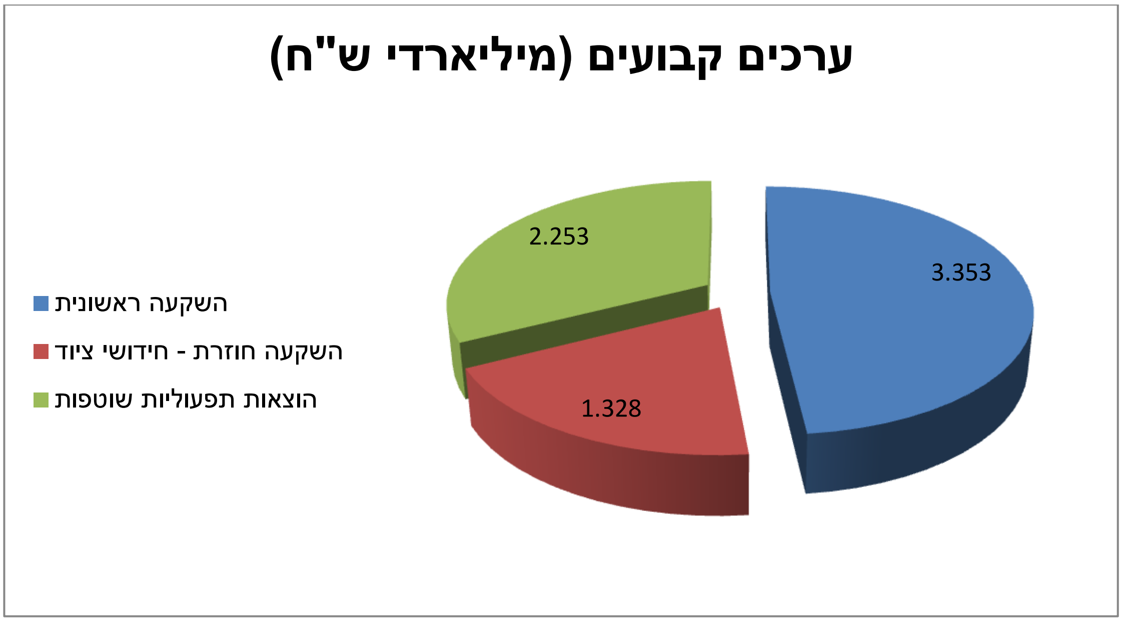
בערכים קבועים, סך העלויות של פריסת מונים חכמים מועשרים בישראל מסתכם לכדי 6.934 מיליארד ש"ח. תרשים 1 מציג את חלוקת העלויות הללו להשקעות והוצאות תפעוליות שוטפות. סך ההשקעות הנדרשות בפריסת מונים חכמים מועשרים בישראל מסתכם לכדי 4.681 מיליארד ש"ח בחלוקה ל: (א) השקעה ראשונית בסך 3.353 מיליארד ש"ח ו(ב) השקעות חוזרות בחידושי ציוד בסך 1.328 מיליארד ש"ח.

עלויות המונים החכמים ואמצעי התקשורת הן המרכיב המשמעותי ביותר בעלויות ההשקעה ונאמדות ב – 46% מסך ההשקעה.

סך הוצאות תפעוליות שוטפות של פריסת מונים חכמים מועשרים בישראל מסתכם לכדי 2.253 מיליארד ש"ח, בעוד עלויות העברת המידע הן המרכיב המשמעותי ביותר בעלויות השוטפות ונאמדות ב – 48% מסך ההוצאות.

סך ההשקעות משמעותי יותר מן ההוצאות השוטפות כיוון שבהשקעות נכללות הן ההשקעה הראשונית (3.353 מיליארד ש"ח) והן ההשקעות החוזרות בחידושי הציוד (1.328 מיליארד ש"ח).

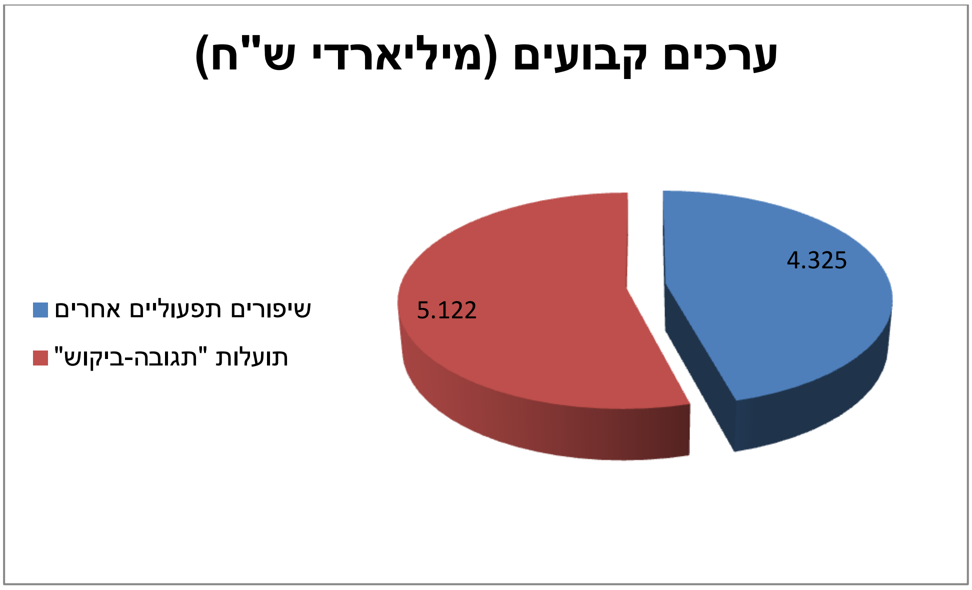
תרשים 1: חלוקת סך העלויות לפי השקעות, השקעות חוזרות והוצאות תפעוליות שוטפות



תועלות הנובעות מפריסת מונים חכמים "מועשרים"

סך התועלות הנובעות מפריסת מונים חכמים מועשרים בישראל מסתכם לכדי 9.447 מיליארד ש"ח. תרשים 2 מציג חלוקה לתועלות תפעוליות ותועלות הנובעות מ"תגובה-ביקוש" ("Demand-Response Benefits"). סך תועלות תפעוליות מסתכם לכדי 4.325 מיליארד ש"ח כאשר תועלות מאופטימיזצית רשת הן המרכיב המשמעותי ביותר (47%). סך תועלות "תגובה-ביקוש" מסתכם לכדי 5.122 מיליארד ש"ח כאשר התועלות מקיטון בצריכה הן המרכיב המשמעותי ביותר (51%)

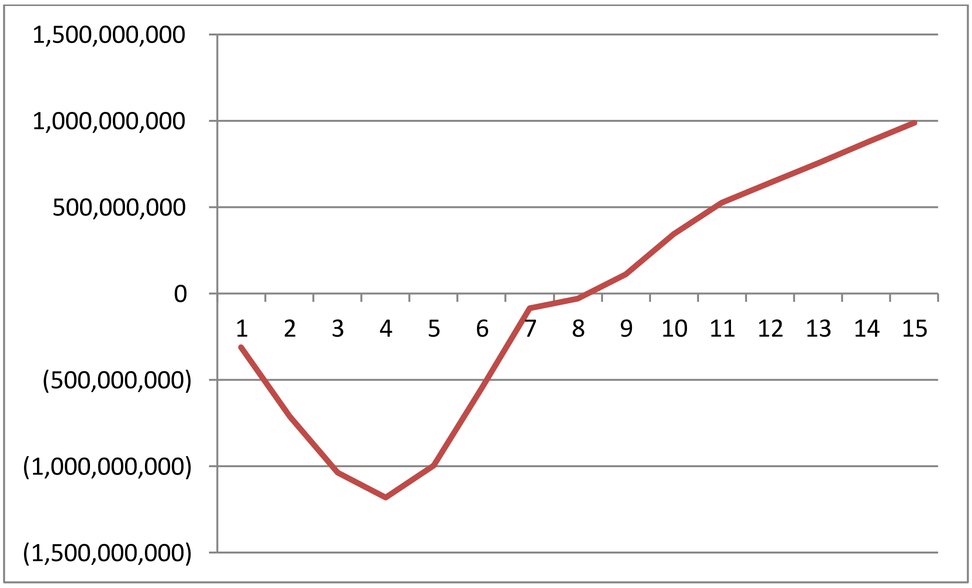
תרשים 2: חלוקת סך התועלות



<u>תוצאות עיקריות</u>

לאורך 15 שנות המודל, לפריסת מונים חכמים מועשרים בישראל יש ערך נוכחי נקי של 986.73 מיליון ש"ח. תרשים 3 מציג את התפתחות ה – NPV (ערך נוכחי נקי) לאורך תקופת המודל (בסופה של כל שנה קלנדרית) בהינתן שיעור היוון של 7%. ביצוע ההשקעות הראשוניות במערכות המידע (IT) בסך 407 מיליון ש"ח נפרס על פני 3.5 שנים ולאחריו, ה – NPV עולה בקצב חיובי מתון. בשנה החמישית יש עיקול חד של הגרף אשר נובע מהשקעה נדחית בתחנת כוח חדשה (התועלת נפרסת על פני שלוש שנים ביחס של 20%-40%-40%). בשנה התשיעית אנו מקבלים לראשונה ערך נוכחי נקי חיובי.

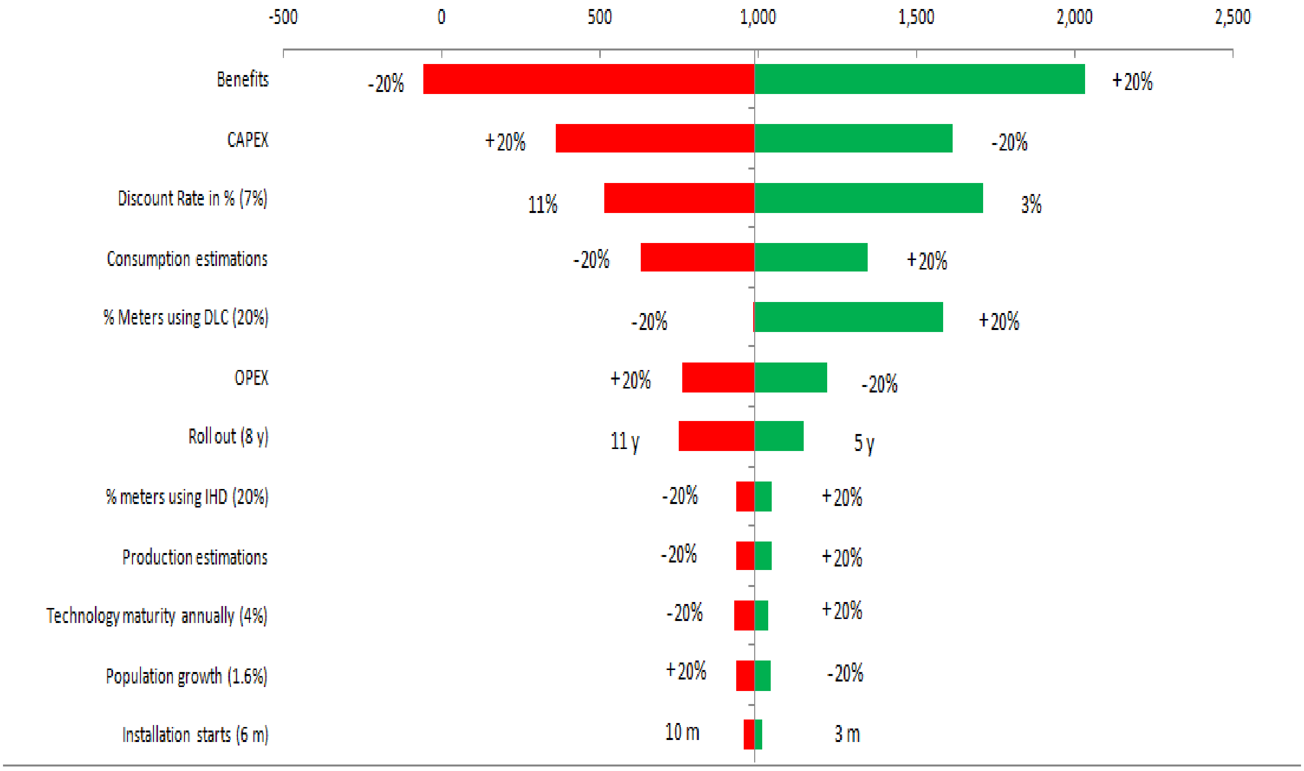
תרשים 3: ערך נוכחי נקי בשנים 2015-2030 בהינתן שיעור היוון 7%



ניתוח רגישות

בתרשים 4 ניתן לראות את רגישות הערך הנוכחי הנקי למשתנים השונים. המשתנים בעלי ההשפעה הגבוהה ביותר על ה – NPV הם: (1) תועלות, (2) השקעות, (3) שיעור ההיוון ו (4) הערכות צריכת החשמל. ניתן לראות שאנו שומרים על ערך נוכחי נקי חיובי לאורך טווח רחב של מבחני רגישות המבוצעים מול משתנים שונים. קיטון בתועלות בגובה 20% הוא המשתנה היחיד אשר לו הפוטנציאל להפוך את ה – NPV לשלילי. ראוי גם לציין שה – NPV עדיין ימצא בטווח החיובי היה וההשקעות בפריסת המונים יהיו גבוהות ב – 20% מן ההערכות שלנו.

תרשים 4: ניתוח רגישות, שינויים בערך נוכחי נקי (NPV)



7. שילוב התעשייה הישראלית

המיקוד העולמי על אנרגיה נקיה וחיסכון באנרגיה הפך לגורם מפתח לקידום רשת חכמה, אשר משלבת את מערכות האנרגיה והתקשורת . התפתחות זאת הופכת הרשת החכמה לפתרון מושלם לאבולוציה של תעשיית ההיי טק .

בתעשיית ההיי טק והאלקטרוניקה הישראלית יש יותר מ 2000 חברות אשר יכולות לספק שירותים ומוצרים לפרויקט הרשת החכמה. הרשת יכולה להוות מנוע צמיחה לחברות אלו ע"י כניסה לתחום עיסוק חדש.

על התעשייה לנקוט בפעולה וללמוד את:

- הדרישות הספציפיות של מערכות האנרגיה .
- התקנים הבינלאומיים
- המוצרים הזמינים הנוכחיים,
- הפרופילים של לקוחות בשוק האנרגיה והצרכים שלהם
- היתרון העסקי בשילוב עם ניתוח סיכונים .

בהתבסס על התוצאות כל חברה יכולה :

- להעריך את הרווחיות של התאמת קו המוצרים שלה למגזר האנרגיה .
- להעריך את הרווחיות של הקמת פעילות מקומית.
- לגייס את המימון על ידי קרנות הון סיכון או אחרים.
- לתכנן חדירה לשוק הבינלאומי

CHAPTER 1

Smart grid review and world trends

Daniel Sfez

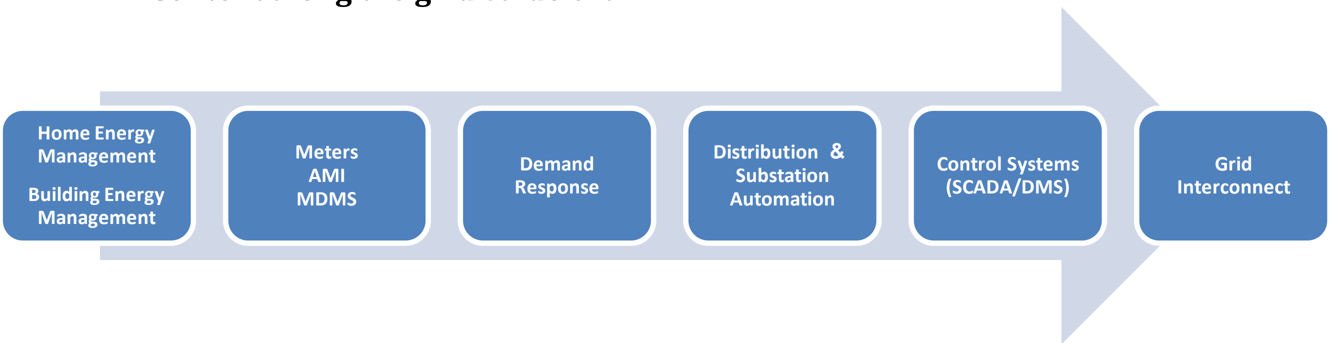
1. Smart Grid review

- **Smart Grid definition**

Bring knowledge to power.

A **smart grid** is a modernized electrical grid that uses information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.

- **Content along the grid value chain**



- **Smart grid- Goals and priorities**

Smart grid goals may be classified by the following different categories:

- Aggregate level
    - Global
    - National
    - Operators (IEC, Private producers).
    - Customers (Industry, commercial, private).
- Operational level
- Operational/Technical
- Marketing.

Each player has its own different preferences. The point of view of the operator is not necessarily matching to that of the customers, manufactures, service providers and so on. This paper is trying to represent the nation interest. It is somehow evasive, but it assures optimization of all benefits in favor of the population.

A general statement in line with this objective is: **<u>To transform the electric grid to achieve sustainable energy future for the public good</u>**. ***Smart grid will act as a backbone infrastructure, enabling a suite of new business models, new energy management services and new energy tariff structures.***

The Operational and Technical goals are mainly related to factors as reliability, survivability, efficiency, security, resilience, and have a direct impact on peak demand reduction, decrease of minutes of interruptions, integration of renewable, and reduction of emissions.

The marketing goals has to do mainly with implementation of intelligent real time pricing, reduction of monthly bill payments by controlling electricity consumption and turning the typical energy customer from being passive to being active.

It should be noted that Israel is an electrical island with stand-alone grid. The Smart Grid will allow balancing of power demand and supply.

The following is a detailed list of goals classified by the main stakeholder who benefits the results:

Goals	**Categories**	**Global**	**National**	**Operators**	**Customers**
Increase quality of supply – reliability improvement				+	
Ensure system survivability.				+	
Peak demand reduction.			+		
Improve security of energy supply			+		
Ensure operational and energetic efficiency: Decrease average customer minutes of interruptions.					+
Improve control of the distribution system.				+	
Reduction of emissions.		+			
Reduce operational and maintenance cost.				+	
Asset and Resource optimization.			+		

Improve resilience (malicious acts, terrorism, theft, frauds).			+	
Provide self healing.			+	
Integration of renewable energies		+		
Integration of electronic vehicles.		+		
Improve ratio of cost/benefit of energy inputs.			+	
Reduction of electric monthly bill payments.				+
Overall energy consumption reduction.		+		
Accessibility to real time information.		+		
Controlling electricity consumption		+		
Introduction of new services and products.				+
Turning a passive customer into an active one - customer Marketing Energy Management				+
Energy efficiency savings.		+		
Demand site management.			+	
Accurate billing.				+

- **The SG benefits to the energy sector and the national economy**

By optimizing a non-optimized system or a system that was built without long term planning, we can expect a substantial profit. The profit is directly related to the gap between the existing grid situation and the best available technology at the date of implementing.

If we are talking about privatized power market where each power plant is a sole company and the grid is divided by different transmission companies like in the US there is a lot to do at the HV/MV level to create a coherent system, especially where there is interconnections. In Africa the situation is a little bit different where nothing is existing the smart gird need before a gird and then to make it smart. In Israel we have on grid manager and the grid is well managed at the sub-station level and the work will be focused on the domestic/industrial level.

In any case by sharing the power consumption data with the end user and to share the profit by "smart" energy utilization we can expect a real power consumption optimization/profit of 5 to 10%.

For a country having 13 GW installed, it is equivalent to non-building a power station of 1,000 mw equivalent to 1,000,000,000 $ Capex and 1,000,000,000 $ Opex. The associated emission reduction impact is also huge depending on the technology used in the same point of time: gas, coal, renewable etc'...

The side benefit is by having a "smart" control and knowledge of the grid the country will be able to optimize decisions on the next power generation technology and renewable integration.

2. World Trends

- **Regulations**

The regulation is needed in order to fill the gap between the time the smart grid will show the real benefit and the period of investment. This phenomenon is called "CAPEX time-shift problem".
Each country is solving that in different ways and in different incentive levels.
In any case there is no full recovery regulation in any country and this is the main reason that the smart grid integration is suffering of lack of dynamism.
The country that will be able to see the global aspect of the smart grid integration will be the one that may implement the technology in the highest level and consequently get profit of the smart grid sooner that the others.
The monopolistic/centralized aspect of the Israeli power generation and distribution may contribute to the smart grids regulation but on the other hand the bureaucracy can affect this dynamism. The dynamic pricing (as the Taoz) is one of the main booster of the Smart Grid integration at the demand level.
Being oriented in the right manner and due to the fact that Israel did some progress in the right way (at the sub-station and country level) we found that by adopting the right incentive regulation **Israel can be one of the advanced countries in the smart Grid field**.
There is an enormous quantity of data available. The following links will focus the reader in the necessary data to get the whole picture.
The summary of the regulation status in Europe can be found in the following link pages 31 to 39 by countries.
http://www.eurelectric.org/media/25920/eurelectric_report__on_reg_for_sg_final-2011-030-0131-01-e.pdf
The summary of the regulation status in USA can be found in the following link pages 1 to 7 by states.
http://www.eia.gov/analysis/studies/electricity/pdf/smartggrid.pdf

- **Technologies**

The technologies involved in the smart grid solution are:

~ Communication
~ Information technology - IT
~ Demand response
~ Meter Data Management - MDM
~ Smart metering
~ Centralized Grid Management System
~ Energy storage
~ Security
~ Transmission
~ Billing
~ Load sharing
~ Monitoring and Diagnostic Tools
~ Sub-station control and automation
~ Electrical vehicles
~ Smart home and building
~ Renewable energies

- ~ Real time data acquisition
- ~ High efficient appliances
- ~ High efficient industrial equipment
- ~ Energy efficiency in industry
- ~ Customer education
- ~ Data Analyzing Tools And Expert Systems

It is important to mention that the main key success of the technology deployment in the smart grid field is the **interoperability** that will allow to all the components to talk one to each other taking in consideration that up to date there is no-one that can give the whole spectrum from in house developed technology.
The **standardization** is also an important factor as well for the successful smart grid integration.

- **Deployments**

Following are some deployment examples.

China: The Chinese government has developed a large, long-term stimulus plan to invest in water systems, rural infrastructures and power grids, including a substantial investment in smart grids. Smart grids are seen as a way to reduce energy consumption, increase the efficiency of the electricity network and manage electricity generation from renewable technologies. China's State Grid Corporation outlined plans in 2010 for a pilot smart grid program that maps out deployment to 2030. Smart grids investments will reach at least USD 96 billion by 2020.

United States: USD 4.5 billion was allocated to grid modernization under the American Recovery Reinvestment Act of 2009, including: USD 3.48 billion for the quick integration of proven technologies into existing electric grids, USD 435 million for regional smart grid demonstrations, and USD 185 million for energy storage and demonstrations.

Italy: Building on the success of the Telegestore project, in 2011 the Italian regulator (Autorità per l'Energia Elettrica ed il Gas) has awarded eight tariff-based funded projects on active medium voltage distribution systems, to demonstrate at-scale advanced network management and automation solutions necessary to integrate distributed generation. The Ministry of Economic Development has also granted over EUR 200 million for demonstration of smart grids features and network modernization in Southern Italian regions.

Japan: The Federation of Electric Power Companies of Japan is developing a smart grid that incorporates solar power generation by 2020 with government investment of over USD 100 million. The Japanese government has announced a national smart metering initiative and large utilities have announced smart grid programs.

South Korea: The Korean government has launched a USD 65 million pilot programme on Jeju Island in partnership with industry. The pilot consists of a fully integrated smart grid system for 6 000 households, wind farms and four distribution lines. Korea has announced plans to implement smart grids nationwide by 2030.

Spain: In 2008, the government mandated distribution companies to replace existing meters with new smart meters with no additional cost to the customer. The utility Endesa aims to deploy automated meter management to more than 13 million customers on the low voltage network during 5 years, building on past efforts by the Italian utility ENEL. The communication protocol used will be open. The utility Iberdrola will replace 10 million meters.

Germany: The E-Energy funding program has several projects focusing on ICTs for the energy system.

Australia: The Australian government announced the AUD 100 million "Smart Grid, Smart City" initiative in 2009 to deliver a commercial-scale smart grid demonstration project. Additional efforts in the area of renewable energy deployments are resulting in further study on smart grids.

United Kingdom: The energy regulator OFGEM has an initiative called the Registered Power Zone that will encourage distributors to develop and implement innovative solutions to connect distributed generators to the network. OFGEM has set up a Low Carbon Networks fund that will allow up to GPB 500m support to projects that test new technology.

France: The electricity distribution operator ERDF is deploying 300 000 smart meters in a pilot project based on an advanced communication protocol named Linky. If the pilot is deemed a success, ERDF will replace all of its 35 million meters with Linky smart meters from 2012 to 2016.

Brazil: APTEL, a utility association, has been working with the Brazilian government on narrowband power line carrier trials with a social and educational focus. Several utilities are also managing smart grid pilots, including Ampla, a power distributor in Rio de Janeiro State owned by the Spanish utility Endesa, which has been deploying smart meters and secure networks to reduce losses from illegal connections. AES Eletropaulo, a distributor in São Paulo State, has developed a smart grid business plan using the existing fibre-optic backbone. The utility CEMIG has started a smart grid project based on system architecture developed by the IntelliGrid Consortium, an initiative of the California-based Electric Power Research Institute.

Source: http://www.iea.org/publications/freepublications/publication/smartgrids_roadmap.pdf

- **SG progress by continents.**

In the US, Florida Power & Light completed in April a four-year effort to create what's being considered as one of the largest smart grid projects from home to power plant. Working with GE, the utility installed 4.5 million smart meters and 145 substation upgrades in 35 counties, as part of a program called Energy Smart Florida. The new system helps anticipate disturbances on the grid prevent outages and restore power quickly in a state often hit by destructive hurricanes. The utility can diagnose system problems remotely and make repairs before issues occur. FPL received $200 million in federal stimulus for the project, the maximum granted per utility under the American Recovery and Reinvestment Act of 2009, which initiated several major US smart grid efforts. In all, the US spent about $4.3 billion on smart grid in 2012, according to BNEF.

In the US Northeast, smart grid had a chance to show off its stuff during Superstorm Sandy, a devastating October 2012 storm that knocked out power for weeks or even months for some buildings that were too damaged for immediate reconnection to the grid. Utilities with sophisticated communications networks - the hallmark of smart grid - were able to identify outages on the system more quickly as smart meters signaled trouble back to the utility's central control. "The IT system, the operation system, doesn't put the wire back up in the air, but it tells you where these problems are," said Brad Williams, vice-president for industry strategy at Oracle Utilities, an information technology company that serves several of the large utilities in the Northeast.

In China, Honeywell has completed first smart grid demand response project in the Tianjin Economic-Technological Development Area (TEDA). Honeywell installed automated demand response in commercial, industrial and government facilities, as a way to reduce need on the grid to run expensive peak power plants and cut emissions and costs. The Honeywell technology allows customers create customized energy reduction strategies that utilities put into action when the grid is under strain. The project is part of a joint US-China energy co-operation program helping to advance China's long-term goal of creating a robust, national smart grid by 2020. To that end BNEF says China's investments in smart grid rose 14 per cent in 2012 to $3.2 billion.

In the Netherland's, PowerMatching City Hoogkerk district calls itself as "the first real-life smart grid community in the world" - a kind of living lab initially made up of about two dozen households. Participants use many of the gadgets and appliances appropriate for smart-grid equipped households: micro combined heat and power systems, hybrid heat pumps, smart meters, PV panels, electric vehicles and charging stations, wind power, and smart household appliances. The homes are meant to demonstrate how we will all use electricity by 2030. DNV KEMA Energy & Sustainability, an energy consulting and testing & certification firm, is leading the initiative.

In Sweden, ABB and the utility Forum are helping the Stockholm Royal Seaport to become an energy-smart district of the future. The goal is to reduce carbon dioxide emissions attributable to each person in the district from 4.5 tons per person to 1.5 tons, as the smart seaport will become a reality through 2030. The project includes a range of energy innovations, from fuelling ships with electric grid power rather than dirtier diesel, to helping homeowners produce 30 per cent of their own electricity through solar and wind energy, and store excess power in electric vehicles. The project focuses on various technologies helping residents become "prosumers" - both consumers and producers of power, who can buy and sell in the energy marketplace. ABB is providing a smart control centre to manage all of these technologies, according to Gary Rackliffe, vice president of smart grids for ABB, a power and automation technology company.

In Australia, the largest electricity network, Ausgrid, is leading a $100 million initiative called Smart Grid, Smart City in Newcastle, Sydney and the Upper Hunter region of New South Wales. The three-year project tests various new energy technologies and pricing schemes with 30 000 households. Ausgrid is experimenting with a range of smart grid devices and approaches from fault-isolating equipment that allows crews to monitor supply remotely to home energy devices, distributed generation, storage, electric vehicles and smart homes. The program is being rolled out through 2013.

In Canada, Ontario has installed small meters for all accounts. About 4.35 million customers were on time-of-use rates as of June 2012. About a dozen companies, among them GE, Siemens and IBM are working on refining smart grid through various province-funded projects. The province is testing in-home energy displays, leveraging data to manage load, advancing grid automation and self-healing, and integrating renewable and electric vehicles.

Ecuador, is the leader among Latin American countries. It released in March 2013 a three-phase smart grid roadmap to 2030. The plan is designed to promote efficiency, adopt new technology and gain better grid awareness and control. Ecuador will install foundational technologies and expand its distribution and transmission over the first four years. The second four-year phase will bring advanced technologies, among them volt and volt-ampere reactive control and decentralized power. In the third phase, from 2023 to 2030, the country will install micro-grids, advanced load management and other measures.

Source: http://www.powerengineeringint.com/articles/print/volume-21/issue-5/features/more-of-a-journey-than-a-destination.html

CHAPTER 2

Solutions, Technology & Road Map for Smart Grid Deployment in Israel

Dan Weinstock and Emek Sadot

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1. Executive Summary

Traditionally, the power sector has adapted and reinforced the power grid by laying more and thicker cables in the ground, building more substations and securing access to sufficient generation capacity. The consumers have been primarily "passive" with predictable and regular consumption patterns.

Electricity consumption and generation in Israel is set to change significantly in the coming years. This will include the following trends:

- Electricity customers will demand new services as they replace oil-fired burners with gas and solar energy
- Emergence of private production facilities
- Replacement of traditional petrol-powered vehicles with electric vehicles / plug-in hybrid vehicles
- Growing public demand to better utilize existing assets rather than building new ones
- The general trend toward customer information-visibility, sharing and engagement

The electricity sector should be ready to provide these services with the same high level of delivery quality as today.

Smart Grid is a new approach to meeting the needs of the new (power) world, where consumers will be able to interact with the power system for both consumption and generation through automated and intelligent control of their electrical appliances, thereby acting as resources for the power system.

Smart Grid will be manifested through series of technologies addressing the 2 main segments:

3. The grid itself - assets add network - from generation facilities to end consumers.
4. End consumers and small scale generation facilities.

Technology-wise, Smart Grid would be seen as "one system to rule them all" with 4 main sectors, which overlap and complement each other. Each sector presents different challenges and requires different solutions, as follows:

1. **The grid** – from central generation plants through transmission and distribution networks and facilities, the Smart Grid will offer higher asset utilization, fewer power outages, energy saving, reduced CAPEX (postponing reinforcement) and OPEX (better maintenance), problem prediction, enhanced power delivery quality, better renewable energy integration, improved planning and forecasting. These improvements will be implemented through a variety of technologies all based on real-time monitoring along the grid, which communicates to the Smart Grid central control system that supervises it.
2. **End consumers and small-scale generation facilities** – Smart Grid will revolutionize the way end customers interact with the power system. End customer appliances and small-scale generation facilities will be connected to the Smart Grid control center, thus offering a new landscape of services and opportunities to end customers as well as to the grid operator and demand response vendors (e.g. flexibility). End customers' Smart Grid technology will be based on a home communication network (i.e. HAN) connection to a smart meter, which relays the data upstream to the Smart Grid control center. Alternatively, dedicated in-house hardware will be installed, which may replace or supplement the smart meter.
3. **Flexibility** – enabling home power appliances and small-scale generation facilities to respond to the power system needs offers a new kind of services and products for the benefit of society. Flexibility, in this context, is defined as the ability of end customer appliances connected to the power system to change their behavior to meet the needs of the power system. Flexibility will be achieved by means of communication from end consumption or production units directly to the Smart Grid control center or through demand response aggregators.
4. **Smart Grid control center** – in the heart of Smart Grid lies the control (IT) center system, which is connected to all end units and manages all services.

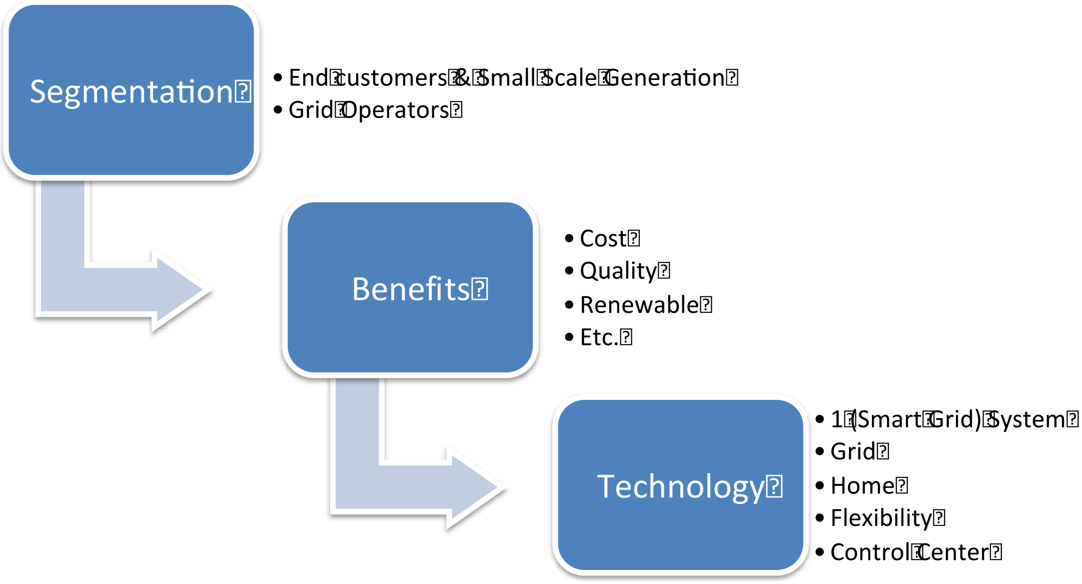


Figure 1: Segmentation, Benefits and Technology

2. Introduction

The Smart Grid Solutions, Technology & Road Map Deployment chapter discusses the landscape and alternative solutions, services, technologies and deployment aspects of the Israeli Smart Grid.

This chapter is organized as follows:

- Section 0 describes Smart Grid segmentation.
- Section 4 describes the benefits and services that Smart Grid provides to each segment.
- Section 5 describes the technologies which enable the expected Smart Grid benefits.

3. Segmentation

In order to explore the relevant Smart Grid solutions, technologies and roadmap we will start by defining the different segments to which Smart Grid applies and the benefits it will provide to each segment. To this end the energy market can be viewed as 2 distinct areas, each of which has its own characteristics such as benefits, solutions and technologies, etc.

1. The grid itself - assets add network - from generation facilities to end consumers.
2. End consumers and small scale generation facilities.

3.1 Grid Operators

The energy grid refers to the legacy assets, network and facilities, which provide the 3 key elements: generation, transmission and distribution facilities.

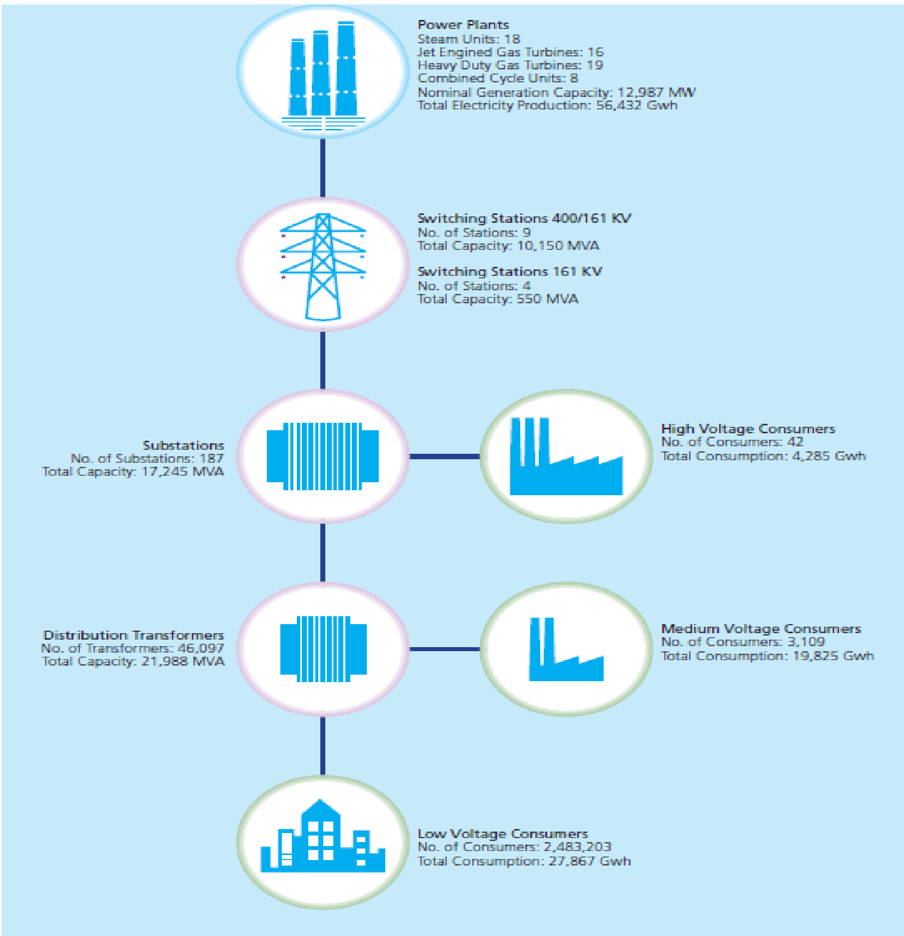


Figure 2: Generation, Transmission & Distribution Facilities (2010)

3.2 End Customers and Small Scale Production

End customers are split into 3 main categories:

3.2.1 Household/SME

About 2.5 million households/SME are present in Israel, which consume around 32.8% of the total electricity and are usually characterized by a low connection capacity (i.e. 3x25A or 1x40A for households), which indicates a relatively low individual consumption rate and volume.

3.2.2 Industry

Industrial facilities (including agricultural facilities and water pumps) consume around 67.20% of the total electricity and are usually characterized by a large connection capacity, which implies higher customer flexibility in terms of how they are able to consume electricity.

3.2.3 Small Scale Generation

Small scale generation represents various production facilities, which range from commercial PV, diesel generator to windmills, etc.

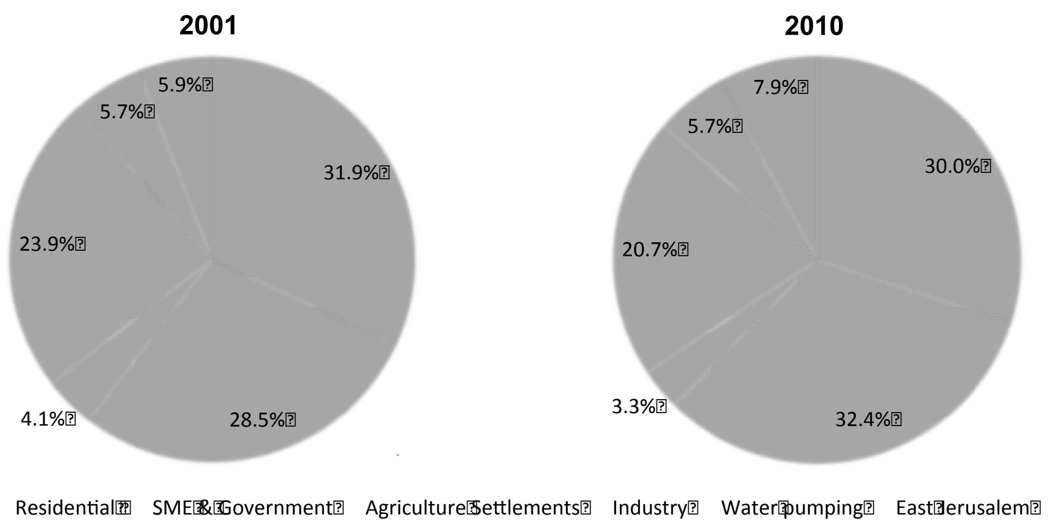


Figure 3: Total Consumption by Sectors

4 Smart Grid Benefits / Services

This section outlines Smart Grid benefits and services for the two main segments (e.g. end customers and grid) described above.

4.1 Smart Grid Beneficiaries

The table below summarizes the Smart Grid "beneficiaries" – the entities that will gain from implementing Smart Grid.

Smart Grid Beneficiaries	
Grid Operators	▪ Production Facilities ▪ Transmission System Operators ▪ Distribution System Operators
End Customers	▪ Household/SME ▪ Industry ▪ Small Scale Generation

Table 1: Smart Grid Beneficiaries

4.2 Grid Operators Smart Grid Benefits / Services

Table 2 below lists the grid operators' Smart Grid benefits and services:

Grid Operators' Smart Grid Benefits / Services	
Cost & Quality	▪ Improved system stability resulting in higher security of delivery, which will reduce duration of power outages (e.g. time of energy not supplied) ▪ Better utilization of existing grid, thus avoiding reinforcement of network, assets and production facility (avoid CAPEX) ▪ Holistic, comprehensive, end-to-end and real-time visibility of all grid assets (reduce OPEX) ▪ Elevate energy efficiency ▪ Reduce energy cost ▪ Elevate quality of energy delivery ▪ Faster remedy of faults in the power grid by identifying problems in real-time and automatically fixing ▪ Problem prediction (before it happens) ▪ Facilitate renewable energy integration into the mix

Table 2: Grid Operator Smart Grid Benefits / Services

4.3 End Customer Smart Grid Benefits / Services

Table 3 below lists the end consumers Smart Grid benefits and services:

End Customer Smart Grid Benefits / Services	
Cost Saving	▪ General energy savings and lower electricity prices for consumers who use managed / intelligent consumption units and are enrolled in a relevant demand response program. ▪ Minimize the total facility electricity cost, based on electricity price forecasts, by consumption planning of the various available units. ▪ Keep power load below a certain threshold in order to save connection fees, by managing various local consumption units according to the metered total load on the connection.
Local production unit	▪ Self-consumption is economically attractive as the customer doesn't have to pay taxes and electricity transportation costs when self-consuming.
Renewable	▪ Customers may wish to subscribe to non-emission (renewable) electricity delivery.
Personalization	▪ Being aware of own consumption, production and storage data. ▪ Personalization services and products offered by grid operators.

	▪ Customer's immediate information sharing from grid operators. ▪ Customer interaction with the power system and grid operators.  Figure 4: Visibility & Personalization

Table 3: End Customer Smart Grid Benefits / Services

4.4 Flexibility Providers Smart Grid Benefits / Services

Table 4 below lists the energy suppliers or grid service aggregators (i.e. flexibility providers) Smart Grid benefits and services as reflected by the end customers and small-scale production.

Flexibility Smart Grid Benefits / Services	
Flexibility	▪ More options to create power balance in a less expensive and more efficient way ▪ Increased integration of renewable energy through flexibility offered by electric vehicles, plug-in hybrid ▪ Increases the market opportunity of secondary and tertiary reserve programs ▪ Peak Shaving (demand response) ▪ Balancing / frequency regulation ▪ Voltage control

Table 4: Flexibility Smart Grid Benefits / Services

5 Technology

The technology chapter describes technologies needed to support the Smart Grid benefits and services described above.

5.1 Introduction

The way towards an intelligent power grid can be described briefly in three phases:

1. Facilitating in the short term
2. Establishment in the medium term
3. Commercialization in the long term

Figure 5: Smart Grid Realization Phases

In order to follow these steps, a smart grid will require close coordination across the interfaces of the power system. It will therefore be necessary to establish IT systems capable of receiving and processing data about the status of the power system online, based on standard mechanisms and protocols. These IT systems should make it possible to fulfill the wishes and needs of the consumers without overloading the power system and thus reward the consumers for their flexibility.

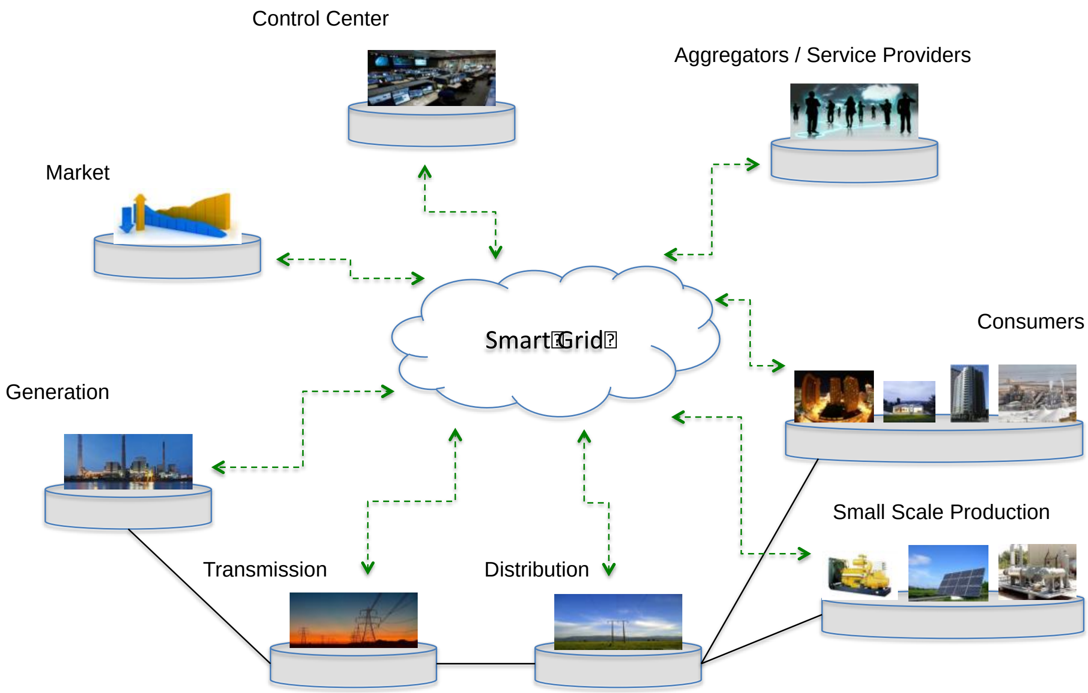
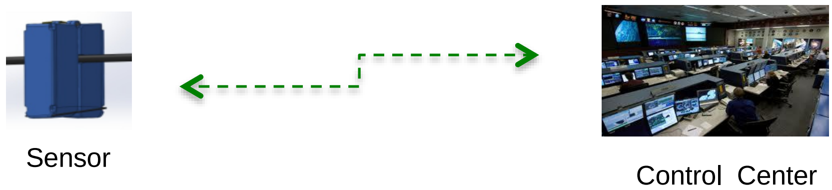


Figure 6: One System to Rule Them All

5.2 Grid Operators Smart Grid Technologies

Measuring the condition of the transmission and distribution network is a prerequisite for ensuring that the distribution network does not overload. Consequently, measuring equipment should be installed at nodes and along the line of the transmission and distribution network, particularly in those areas that are at risk of such overloading. This measuring equipment should be able to send real-time information about the condition (e.g. load) of the grid.

Technology	
Description	1. Sensors - precisely measure a wide variety of electrical parameters (e.g. current values and discrepancy, frequency, etc.). 2. Control Center (CC) - a backend IT solution which collects all data from various in-the-field sensors, processes it and create outputs for the operator and grid operator system, such as:

	a. Real time asset and grid status b. Immediate alarm and fault monitoring c. Failures prediction The CC features components configuration, maintenance activities, fault handling, system administration and performance monitoring of the grid through a comprehensive graphic user interface. 3. Communication – a bidirectional standard communication system facilitates data transaction from the sensors to the CC and vice versa (e.g. maintenance, provisioning, SW upgrade, etc.). The image below describes the system: 
Benefits	Transmission & Distribution sectors benefits: ▪ Postpone / avoid upgrading the grid ▪ Reducing operational costs ▪ Reducing maintenance costs (proactive) ▪ Energy saving per given kWh sold ▪ Maximizing infrastructure utilization & performances ▪ Reduce number and duration of outages (energy not supplied) ▪ Improve electricity Quality of Service
Features	The technology should feature the following Smart Grid capabilities: ▪ Alerts for: o Theft o Current cutoff o Short circuit to ground / single phase grounding short o Short circuit between phases o Current overload o Frequency deviation o Unbalanced current phases o Contamination over power line insulator-strings o Leakage detection – fault prediction o Unbalanced power consumption – recommendation for efficient usage ▪ Reports on: o Asset utilization o Current consumption profile (at various time periods per location/route) o Environmental information (cable and ambient

	temperature, cable inclination and many more) ▪ Concurrent, real time measurements of the grid: ○ Present current and peak current ○ Grid line voltage and peaks ○ Frequency ○ Temperatures (cable, ambient etc.) ○ Vibration, cable movements, inclination etc. ○ Measurements of substation and user provided power (e.g. solar systems) with information on each source It's strongly advised that sensor installation will not require power shutdown and will exploit inductive technology (to avoid high maintenance cost). The CC should process all the information and be able to present current status, utilization, performance, detect faults, produce warnings, predict trends of upcoming faults. In addition, real time collected measurement of the grid should be presented in different views such as tree view, tables, charts and geographic maps to allow the grid operator to analyze and watch the actual real time of the grid.

Table 5: Transmission & Distribution Networks Smart Grid Technology

5.3 Consumers' Smart Grid Technology

Customer services and flexibility features serving the grid operators are managed by one or more electronic units on the consumer's premises - whether it's a private home, SME or industrial facility. These units control the consumption of the flexible electrical appliances in the house or facility. This control can simultaneously maximize the consumer's quality of service and ensure effective interaction with the needs of the power system as expressed through price signals, while at the same time offering flexibility back to the grid operators.

Customer Smart Grid services and flexibility require a home network, and connectivity to smart consumption and production units is mandatory. Smart metering is one technology that can meet connectivity needs. Alternatively, a dedicated demand response home solution can be installed to facilitate flexibility back to the grid operators and customer energy saving.

The advantage of a dedicated demand response home solution lies, to some extent, in a detached model of the traditional energy market structure (bypassing the DSO meter). On the other hand, it cannot offer full Smart Grid services (e.g. it lacks customer visibility into full home consumption, meter remote reading, etc.).

Whether the technology used is a smart meter or a dedicated demand response home solution, it will provide 2 main features:

1. Communication with local (downstream) consumption and production units through HAN technology and upstream with the smart grid CC.
2. Management and control.

5.3.1 Smart Meter Technology

Based on Advanced Metering Infrastructure ("AMI") – comprised of smart meters, real-time two way communications, Meter Data Management ("MDM") software, demand response technologies, and incorporating Geographical Information Systems (GIS) - utilities will be able to reliably and economically optimize the behavior of the grid all the way to the customer level on the low voltage network.

An additional application of this technology is the use of an energy forecasting algorithm model, which analyzes dynamic consumption profiles and forecasted weather to predict energy consumption and where an outage might occur.

Through the smart meter device, the Smart Grid will have functionality to plan outages in critical energy situations by incorporating intelligent capabilities distributed within the smart meters to shed the load of specific customer appliances or specific groups of customers.

Smart meter features 2 communication interfaces: downstream HAN technology toward the consumption and production units and upstream toward the smart grid CC.

1. Downstream, in building communication (HAN) – Wi-Fi, ZigBee and PLC are the 3 competing technologies, where PLC presents a unique advantage of no-coverage barriers. On top of that today's trend is to consolidate PLC and ZigBee HAN technologies (HW and SW) into a single chip.
2. Upstream, to Smart Grid CC – RF, cellular, PLC and fiber-to-the-home are the competing technologies, where no single technology rules. Each technology satisfies a different scenario:
    a. PLC and Fiber-to-the-home – density rollout, for instance country or city wide smart meter deployment, where in plc case a concentrator sits next to the block's transformer.
    b. Cellular – fragmented smart meter deployment ("here and there") where it's not economic to deploy a PLC concentrator next to the block's transformer.
    c. RF – single payable facility with multiple feeding lines and optionally multiple sub-meters (e.g. "kibbutz").

Smart meter with HAN technology will manage and control the house's smart consumption and production units. In normal operation mode it'll need to execute Smart Grid commands, on the other hand the smart meter will need to operate standalone when communication to the Smart Grid is (temporarily) down.

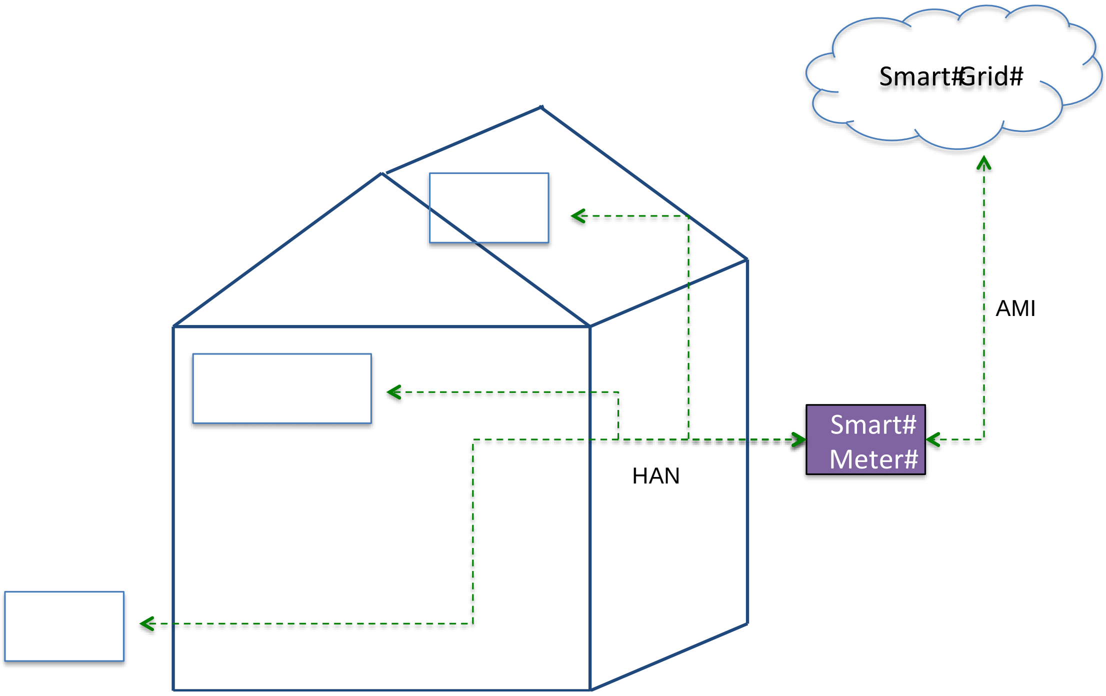


Figure 7: Smart Grid Smart Meter Technology

5.3.2 Dedicated Demand Response Home Solution

A dedicated demand response home solution is composed of:

1. Home communication concentrator, which is self installed and connected to the house's router. Alternatively a home's router technology could be modified and embedded with the required communication technology, making the dedicated communication (hardware) unit unnecessary.
2. A pluggable intermediate unit, which resides between the consumption or production unit and a normal household outlet. Alternatively the consumption or production unit could be modified and embedded with the required technology, making the dedicated intermediate (hardware) unit unnecessary.

Similarly to smart meter, the dedicated demand response home solution features 2 communication interfaces: downstream HAN technology toward the consumption and production units, and upstream toward the smart grid CC.

1. Downstream, in-building communication (HAN) – Wi-Fi and ZigBee are the 2 competing technologies, where PLC may be used if the dedicated hardware is integrated into the home's wireless router.
2. Upstream, to Smart Grid CC – Internet connectivity through customer's existing home wireless router.

The dedicated demand response home solution will manage and control the home's smart consumption and production units. In normal operation mode it'll need to execute Smart Grid commands, but on the other hand the smart meter will need to operate standalone when communication to the Smart Grid is (temporarily) down.

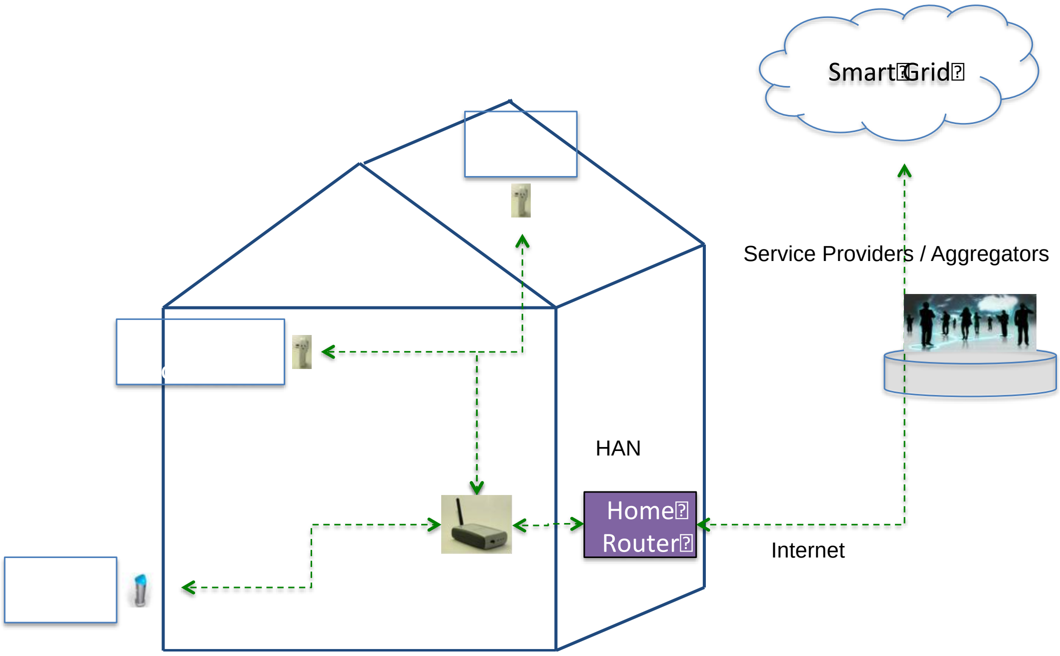


Figure 8: Dedicated Demand Response Home Solution Smart Grid Technology

5.4 Flexibility

Flexibility, in this context, is defined as the ability of end customer appliances (consumption and production) connected to the power system to change their behavior to meet the needs of the power system. For example, a household air conditioner or a privately owned photovoltaic system reduces its capacity because a power line is overloaded, or an electric car that adapts its charging patterns to balance out fluctuating solar energy levels.

With the objective in mind of avoiding upgrading the network and assets, while mainlining high quality energy delivery, the main challenges throughout the transmission network would include flexibility (i.e. balancing consumption and production and maintaining voltage stability) to ensure the stability of the entire power system. Similarly, the main challenge of the extended distribution network consists of handling increased loads due to higher electricity demand and handling increased local production capacity.

Smart Grid will facilitate activating flexibility from the end customer toward the grid operators through set of standard interfaces and protocols and a central Smart Grid IT system. The central system will supervise the process and facilitate several essential functions such as: offering, requesting, trading, dispatching and settlement. The goal is to ensure the efficient integration and exchange of information between all the various components and players involved.

To utilize the flexibility from end customer consumption and production units and on the other hand meet grid operator needs and allow introduction of new players in a seamless and transparent manner - easy market access is necessary. Therefore one of the design principles is to use international standards, which define the required information model, facilitate the process and allow everyone to participate. To that end, two international standards for Smart Grid are pivotal, each one including a number of parts and related standards.

1. IEC 61850 standard for managing distributed units
2. IEC 61970 standard, which covers a wide range of system activities in the power system, for example electricity markets. The information model in IEC 61970 is called the Common Information Model - CIM.

The two information models are being harmonized with a view to defining a combined information model for the entire power system and its associated components and processes.

Generally speaking, 2 mechanisms will incentivize and activate Smart Grid flexibility:

1. Pricing – price signals, static (i.e. TOU table) or dynamic, will incentivize customers to modify their electricity consumption, or small scale production for that matter, to align with the grid operator's needs.
2. Flexibility (pre-defined) product – a product or service which has been clearly defined and agreed in advance by all parties in the marketplace. For example reducing the load in a specified grid area can be activated as and when needed by grid companies at an agreed price.

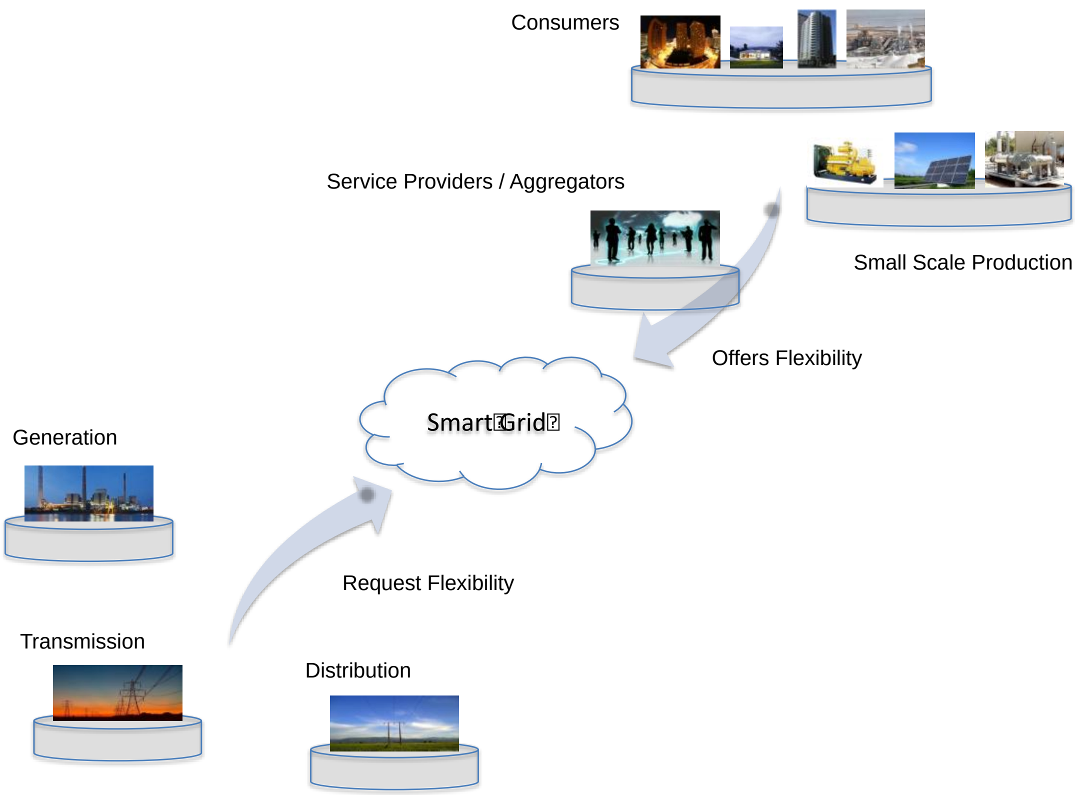


Figure 9: Smart Grid Flexibility Technology

5.5 Smart Grid Technology

Smart Grid control center technology consists of many features described in this section.

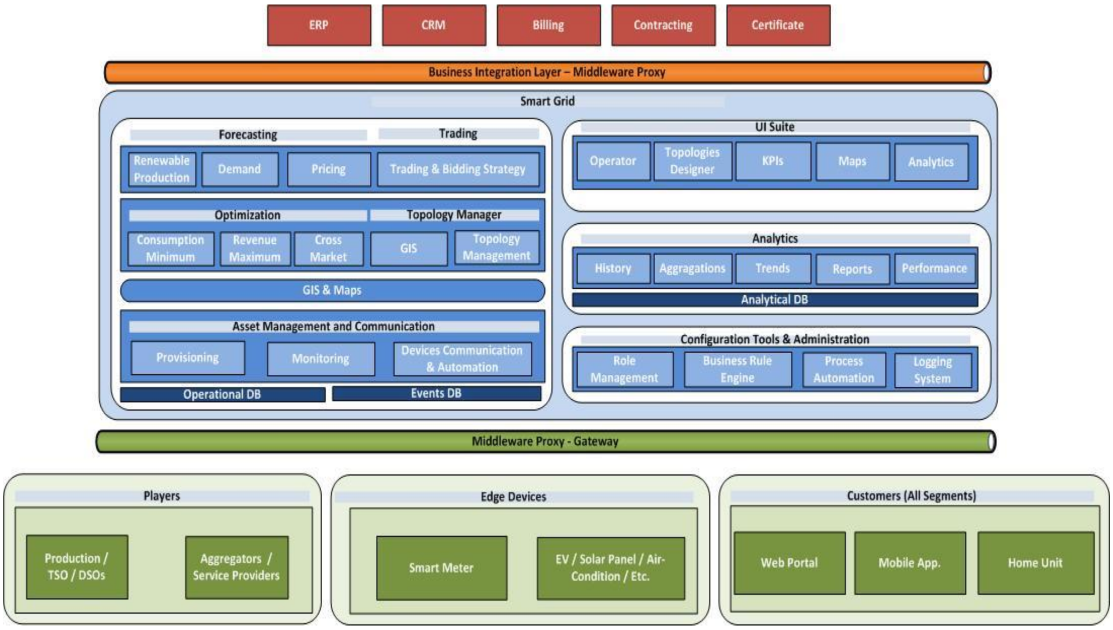


Figure 10: Smart Grid Control Center Technology

Name	Description
Optimization	
Optimization	Optimizing between grid operators' requests and end customer consumption and production units flexibility according to business rules and trading system. Forecasting is yet another technology that processes historical data, trends and current variables in order to calculate consumption, pricing, assets health and production power forecasts.
GIS and Maps	
Maps	Map layer and topology manager to present and change topologies and service status (from a single device up to country level aggregated status).
Asset Management Modules	
Asset management	Asset management capabilities responsible for registering new devices into the system, remote configuration, activation and upgrade of the devices, health status, alerting, etc.
UI Suite	
Operator UI	Primary Smart Grid operator management tool that provides 360 view of all Smart Grid assets, status and processes.
Analytics	
History	Historical data business analytic tools such as trends reports, performance, etc.
Middleware Proxy Gateway	
Middleware	Middleware layer abstract dedicated protocol and interface to various players and devices while maintaining clear and interface to the inner smart grid logic and components.
Player, Edge Devices & Costumers	
Players	Standard interfaces and protocol toward specific entities such as grid operators, aggregators, service providers and end customers.
Business applications	

Biz.	Business applications like CRM, billing, ERP, contracting, etc.

Table 6: Smart Grid Control Center Components & Technology

CHAPTER 3

The End User as a Stake Holder

Juliet Shavit

Executive Summary

Utilities have not made a proactive effort to invest heavily in marketing communications efforts for the simple reason that in regulated environments without competition customers have had little reason to engage with their utility other than call when they had questions about their bill. They want their lights on, then they pay their monthly bill.

As the industry transforms operationally and lays out smart infrastructure for next generation reliability, security and energy reduction, a new paradigm shift is taking place where customers must comply with technology change, and in many cases, even become instrumental in the new service delivery ecosystem.

In a smart grid environment, customers play a critical role in energy reduction as they become more proactive in energy management. This changes dramatically the rules of engagement between utilities and customers.

This paper highlights some key areas utilities must be mindful of as they lay out their AMI customer education programs. By acknowledging the importance of customer education and investing in quality education and communications, utilities will find that their roads are much smoother to travel as they make their way down the smart grid path.

Forward

Utilities have historically had a very one-way relationship with customers. Customer want electricity, they pay their electric bill. Pretty straight forward.

Therein lays the irony of smart grid. While smart grid leverages technology to offer up two way communications between the utility and technology through wireless communications, it also offers up a paradigm shift for a new model for customer communications. A model that moves from information to education to engagement. This paradigm shift is underscored by recent deployments globally that have proven that without the same amount of care given to customer education around AMI, the fulfillment of technology and business objectives of smart grid are not realized.

For the first time in the history of energy and utilities, customers have a significant role to play in the new service delivery ecosystem. If customers do not engage with new tools and reduce energy use, the business case for smart grid is dissolved. Similarly, if customers do not use new online energy management tools and data presentment that come from smart grid investments in technology, the utility is left with shiny new tools.

After all direct load control is only as good as people who sign up for it.

The trend we now see is that in most regulated utility environments, utilities have less and less room to impose programs or rates on customers without justification of a full blown existing customer education plan. In short, smart grid is the catalyst for utilities to change the way they interact with customers, and the way customers interact with them.

As utilities look to role out successful AMI deployments, they should keep in mind a number of best practices that have helped utilities around the globe gather success. One need only look at utilities that have *not,* adopted these strategies to see where the largest failures have been.

Understand Stakeholder Engagement

Stakeholders comprise both internal and external influencers who can ensure the success of an AMI rollout. Internally that means employees from all silos—deployment, marketing, customer care, etc. Making sure you are doing internal communication and have an open structure for communications and planning as you roll out AMI will be critical to the success of the program.

Similarly, customer advocacy groups, regulatory bodies, government, and solutions providers offer up another minefield when it comes to AMI. Carefully navigating that minefield and strategically collaborating will be critical to a successful AMI rollout.

Education should come in phases

Trying to educate a consumer on critical peak pricing before you've swapped out their meter is akin to swallowing a chicken whole. T's simply not possible. Breaking down the elements of information and planning communications in phases will help ensure that customers not only support the rollout, but actually are educated as needed during critical phases.

Understand Your Customer

Market research is a critical component of rolling out customer education for smart grid. While utilities think they know their customers, making assumptions is there biggest faux pas. A good solid research plan to evaluate customer attitude, opinions and understanding before the first meter hits the home should kick off a more complex series of studies to understand how the utility is doing—every step of the way. Make sure your research people sit next to your marketing people.

Build Flexibility and tracking into your plan

If you walk into a pilot thinking you will be sticking to a straight schedule and there is no room for flexibility, you are building yourself a recipe for disaster. Only the most experienced smart grid experts know that agility is key to the success, because no matter how much you think you know about how to get this right, you're probably wrong somewhere. The key is to be prepared to handles challenges as they arise.

Test

Utilities are notorious for thinking that they understand customer behavior. After all, aren't employees all electric customers? This is one of the greatest issues in utility education.

People are different. Segments are different. Regions are different. If you think something works, do the litmus test—ask customers through focus groups, online panels, or any way you can. Testing is critical to customer education and making sure concepts, materials, designs, and tactics resonate.

Monitor

If you follow all of the above strategies, then all you have to do is make sure you are effective. Even though you may see load reduction, you will also want to see how that load is reduced. Customer education could play a critical role in laying the plan for metrics and monitoring of key AMI milestones.

To learn more about these best practices, visit www.smartenergy-ip.com

ABOUT THE AUTHOR Juliet Shavit is President and CEO of SmartMark Communications, LLC. She is also the Founder of SmartEnergy IP™, a research and consulting organization within SmartMark wholly dedicated to smart grid customer education. She currently works with utilities around the world on smart grid customer education efforts. Ms. Shavit has been published both in the US and abroad and is a frequent speaker at events. She has been featured on the cover of *European Communications* and *Mobile Europe* for her leadership role in smart grid customer education. Ms. Shavit can be reached at jshavit@smartmarkusa.com.

ABOUT SMARTENERGY IP™ Smart Energy IP ™ is a research and consulting organization within SmartMark Communications, LLC that is dedicated to helping utilities communicate the benefits of smart grid to customers. As utilities roll out smart grid initiatives – from smart meters to dynamic pricing programs – there are ways to ensure that customers are best prepared to make smart energy choices and positively support these rollouts. SmartMark Communications has over a decade of experience in the energy and utilities customer care domain, helping utilities and suppliers market effectively to customers. For more information, visit: www.smartenergy-ip.com.

Sources:

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CHAPTER 4

The legal aspects of SG deployment

Amnon Epstein

Introduction

The Smart Grid offers various advantages over the traditional electricity transmission system, including improved transmission efficiency, better control and supervision capabilities over the electric grid (especially managing peaks), expanding the range of available services offered to consumers and providing them with the ability to control their consumption and its timing and reduce their bills. However, like in the case of many other technological advances, the current legal system does not fully and comprehensively address all legal issues that may arise in connection with this new technology.

Indeed, Israeli law does not currently provide a specific set of rules or regulations addressing all matters pertaining to the Smart Grid. Accordingly, it is likely that the legislator will have to take into consideration the need for specific legislation involving the Smart Grid, whether independently or as a result of applications submitted by stakeholders. Nevertheless, it is quite certain that not all matters will be specifically addressed by the legislator, hence, when the courts will have to consider such matters, they will have to rely on general areas of law (e.g. privacy, anti-trust) and apply them to the subject matter.

In this chapter, we shall attempt to review some existing provisions of the main areas of the law that are relevant to the operation of the Smart Grid, and will point out certain matters that, in our opinion, should be specifically addressed and regulated.

Privacy

<u>The Right to Privacy</u>

The common proverb about privacy, which was coined by Warren and Brandies, is that the right to privacy is "the right to be let alone."[2] The Israeli courts have adopted this concept and have based such right on the individual's right not to be bothered and his basic right to freedom.[3]

Moreover, following various conventions and treaties that have acknowledged the importance and the status of the right to privacy as a basic right,[4] the right to privacy has been declared a constitutional right in Israel, pursuant to section 7 of the Basic Law: Human Dignity and Liberty.[5] Lastly, certain aspects of the right to privacy also enjoy further protection under the Protection of Privacy Law 5741-1981 (the "**Law**").[6] However, neither the Law nor the case law relating to it, provide an exhaustive definition of privacy.

With regard to a person's home, the right to privacy ensures his *"right to conduct the lifestyle he chooses within the confines of his home, without external interruptions. A man's home is his fortress, and within its walls he is entitled to be left alone, to develop the autonomy of his personal will. In this respect, the right to privacy is, inter alia, the limit over the access that others have to the individual. The right to privacy is designed to ensure that a person is not a prisoner in his own home, and is not forced to expose himself, in his own home. The right to privacy draws a line*

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[2] S. D. Warren & L. D. Brandeis "The Right to Privacy" 4 Harv. L. Rev. (1890) 193 "the right to be let alone". See also [civil] file 8483/02 *Aloniel Ltd.* v. *Ariel McDonald* (March 30, 2004) and the Protection of Privacy Bill, page 206 (Bill 1453, 1980): *"The individual finds himself exposed for everyone to see, in matters which are better kept private, and feels that his personal, intimate affairs are about to become- without good reason- an matter of public knowledge. This new situation requires that the individual's right to privacy is secured."*

[3] The former president of the Supreme Court, Justice Meir Shamgar, explained that a breach of privacy occurs when "*an act… which might cause a person to lose his peace of mind, his sense of personal security and a sense of being able to lead his life in privacy, without his personal affairs becoming a spectacle for others to see…"* (see [further hearing] file 83/9 *Military Appeals Tribunal* v. *Moshe Vaknin*, page 853 (October 30, 1988).

[4] See Article 12 of the Universal declaration of Human Rights, 1948; Article 8 of the Convention for the Protection of Human Rights and Fundamental Freedoms, 1950; and Article 17 of the International Covenant on Civil and Political Rights, 1966.

[5] Article 7 of the Basic Law: Human Dignity and Liberty- *"Privacy: (a) All persons have the right to privacy and to intimacy…(d) There shall be no violation of the confidentiality of conversation, or of the writings or records of the person."*

[6] See the language of Article 1 of the Protection of Privacy Act, 5471-1981: *"No person shall breach another person's privacy without his consent"*. Section 5 of the Law stipulates that a breach of the right to privacy constitutes both a civil wrong and Section 6 adds that in certain cases it may also constitute a criminal offence.

between the personal and the communal, between the 'self' and the society. It serves as a space in which the individual is left to himself, to develop his own 'self', without the intervention of the other individuals in the society."[7]

Privacy and Smart Grid

In the context of the Smart Grid, the main concern regarding the right of privacy is the matter of gathering, protecting and using the information about the customers and their patterns of behavior in their homes.

As part of the Smart Grid's operation, smart meters generate a large amount of information about the customers that is then stored in databases, and may be processed and shared with third parties. Unlike today, where the information gathered by the operator of the grid (IEC) is very limited (the aggregated consumption during relatively long periods (month or even more), contact information and billing information (credit card details etc.)), smart meters will enable the operator of the grid to gather a much larger volume of and more detailed information, including regarding the energy consumption (the amount and time of consumption), the type of appliances used in the unit (a home or an office) and even the number of the inhabitants present at the unit at each given time or the hours in which the inhabitants are active within that unit.

Such valuable information regarding consumption, patterns of behavior and everyday activities of their potential customers, may be of great interest to both governmental and commercial entities. For example, one can assume that insurance companies may be interested to use information regarding hours of presence in the house, in order to determine the insurance premium of their clients.

However, the gathering of such information regarding an individual, and even more so the use and sharing of such information, may infringe the individual's right to privacy in his home, as explained above. Needless to say that the streaming and storage of such detailed information raises further concerns in the context of privacy.

The Protection of Privacy under Israeli Law

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[7] [High Court of Justice] file 2481/93 *Yosef Dayan* v. *Prefect of Jerusalem District, Yehuda Vilk*, page 161 (June 9, 1994).

Under the Law, one may not infringe a man's privacy without his consent (explicit or implied). For such purpose, the Law defines an infringement of privacy as including, inter alia, the publishing (including by transferring to a third party) of any matter that relates to personal, intimate life, including conduct in the private domain.[8] Accordingly, one can argue that unless prior consent has been obtained, any disclosure to a third party of information gathered by smart meters should be regarded as an infringement of the right to privacy, since it relates to the conduct of a person in the private domain.[9]

Moreover, as part of the legal protection of the right to privacy, the legislator deemed it fit also to regulate the matter of gathering, storing and using information in databases, and such matters are indeed regulated under the Law and the regulations enacted thereunder. Inter alia, the Law:

- requires that a database is registered in the case that, inter alia: i) collation of information about more than 10,000 individuals; or ii) the collating entity is a public body;
- limits the right to use the information in a database (including by way of disclosure) only for the purposes for which a database was set up (which should be stated when it is registered);[10]
- sets out certain disclosure obligations upon addressing a person with a request for information that is intended to be stored in a database (e.g. the purpose for which the information is requested);[11]
- sets out the right of a person (subject to certain limitations and exceptions) to review the information regarding himself that is contained in a database and to amend it, if it is not accurate;[12]

[8] Section 2(11) of the Law.

[9] An interesting preliminary question that should be considered by the legislator or that would require an interpretation by the courts is whether the Law and its requirements are applicable at all in this context. Considering the fact that a unit (home or office) may be occupied and used by more than one person, it can be argued that the information is gathered about a group of people (e.g. a family) and cannot be attributed to one individual, and therefore the Law, which relates to an individual's right for privacy, should not be applied in the case at all. On the other hand, it can be argued that while this may be the case in an office, a family and its life within the privacy of its home, being very closely related to an individual's private matters, should not be regarded as separate from the individual and its privacy should be protected under the Law as well.

[10] Section 8(b) of the Law.

[11] Section 11 of the Law. It should be clarified however, that subject to the general prohibition on infringement of the right to privacy mentioned above, the Law does not prohibit the gathering of information about a person without its consent, but merely requires the registration of any database that includes information about persons and the information was not provided to the database by them, on their behalf or with their consent.

[12] Sections 13-14 of the Law.

- sets out the confidentiality obligation of owners and holders of databases (and their employees) ;[13] and
- sets out various security related obligations.[14]

The Law and the regulations impose several additional obligations over public bodies (government ministries and other state institution, a local authority and any other body that performs public functions pursuant to a law, and any other entities so identified by the Minister of Justice). Most importantly in our respect, the definition of information is expanded to include all items about a person's private affairs,[15] and public bodies are prohibited almost completely from disclosing, sharing or transferring of information without the prior consent of that person.[16] Such provisions may prove very important, since the Smart Grid's operator (whether IEC or a new operation) may well be considered a public body for the purpose of the Law (since it performs public functions pursuant to the law) and shall have to abide to such strict limitations.

Protection vs. Efficiency

The matter of disclosure of the gathered information seems to be very important in this context. Based on the US experience, it seems that in order to reach the full potential benefits of the Smart Grid, it is important that various entities, such as Energy Efficiency Service Providers (EESPs), will have access and will be able to analyze the information gathered about consumers (such as consumption patterns and bills). For example, based on such information EESPs can address the consumers and offer them better consumption schemes and rates, or tools for better control over their electricity consumption. For such purpose, various states in the US have enacted several different laws, aiming to enable such flow of information, while addressing privacy concerns.[17]

Similarly, it may be advisable that the Israeli legislator will also consider whether it is satisfied with the current situation, which seems to require the consent of the customer for such disclosure (assuming the Smart Grid's is indeed a public body), or whether it may be advisable

[13] Section 16 of the Law.

[14] Sections 17-17B of the Law.

[15] Section 23A of the Law.

[16] Sections 23B-23G of the Law.

[17] A Regulator's Privacy Guide to Third Party Data Access for Energy Efficiency, Dec. 2012, www.seeaction.energy.gov.

to allow some information to be transferred without such consent. Needless to mention that it is also advisable to consider whether the EESPs shall have the right to request already analyzed data or only in its original form, and who should bear the costs associated therewith.

Ownership of the Information

An ancillary matter is the question of the ownership of data, namely, to whom does the gathered information belong - to the operator or to the customer? And does the customer have the right to request the operator to transfer the information relating to it (whether in an analyzed form or in its original form) to a third party without any compensation?

The answers to such questions are not entirely clear and involve various areas of law, and it is therefore advisable that the legislator specifically address this matter.

The Protection of Privacy Law does not address these questions directly. Not surprisingly, its main concern seems to be with the question of disclosure initiated by the owner of the database. As noted above, it only provides the consumers (subject to certain limitations and exceptions) with the right to review the information that is contained in a database and to amend it if it is not accurate. It should be noted, however, that the Law defines the owner of a database as an "owner" (though it can be argued that such definition relates to the entire database and not to specific information contained therein).

General legislation regarding the rights in non-tangible property also provides only limited help in the attempt to clarify this matter. The Israeli Copyright Act 5778-2007 states that copyright in a work shall not extend to, inter alia, a fact or data, but it shall extend to their expression.[18] Accordingly one can argue that the operator of the Smart Grid does not have any copyright to the crude information gathered by the smart meters. On the other hand, it can also be argued that analyzed data is an expression of such data and therefore, if it complies with the other requirements of the law, it is the property of the operator (who performs such analysis) and should be protected by copyright.

Another general law is the Commercial Torts Law 5759-1999, which, inter alia, provides protection for trade secrets. This statute defines a trade secret as "*commercial information of every kind, which is not public knowledge or which cannot readily and legally be discovered by the*

[18] Section 5 of the Israeli Copyright Act 5778-2007.

public, the secrecy of which grants its owner an advantage over his competitors, provided that its owner takes reasonable steps to protect its secrecy." Accordingly, the operator of the Smart Grid may argue that the information about the consumers is its trade secret, and as such is entitled to certain protection under the said law. However, as the question addresses the very essence of the ownership, it is unclear if such law does indeed clarify this matter.

To conclude, as we have noted above, and based on the experience in other similar matters (e.g. the obligation of banks to disclose credit rating of a customer, at its request, to third parties), it seems highly advisable that the legislator will specifically address this matter and clarify the a person has a right to request the operator to disclose the information gathered about him (whether in crude or in analyzed form) to third parties who should bear the costs associated therewith.

Antitrust

IEC was declared as a monopoly in several areas, including in the supply (production and sale), transmission and distribution of electricity. As such, the law limits its ability to use its position in a way that could impair competition or be contrary to the public good.

In addition, the Israeli courts have adopted and applied the Essential Facility doctrine, which was developed in order to compel, under certain circumstances, the holder of a monopoly to allow others, including its competitors, to use the monopoly's asset or facility.

According to the case law of the Israeli Antitrust Court, three cumulative conditions must be met in order to impose a duty on a holder of a monopoly to allow access to the essential facility:

> “(1) control of the essential facility by a monopolist; (2) a competitor’s inability practically or reasonably to duplicate the essential facility; or the denial of the use of the facility to a competitor; and (3) the feasibility of providing the facility.”.

Even if the facility can be duplicated, but the incurred costs, or the period of time required for its duplication, render it financially unrealistic to duplicate the facility given the state of the relevant market and in light of the foreseen competition and its financial attributes, the facility will still be regarded as an essential one, as long as it is shown that the prevention of access to the facility creates a barrier to entry which should be viewed as financially or otherwise impassable under the circumstances. It follows that it is not required that the duplication of the essential facility, or the creation of competition in the relevant market, will be completely unattainable in order for the essential facility to be considered as one: it is enough that under the conditions of the relevant market the erection of an additional facility for the purpose of parallel usage will take too long or cost too much, so that the probability that such a facility will indeed be erected (and the probability for the subsequent creation of competition along the production chain) will be low enough.

In our case, it is quite safe to assume that the operator of the Smart Grid will be considered a monopoly and the Smart Grid itself (and maybe even the information gathered in connection therewith) will be regarded as an essential facility, and the said doctrine will be applied. As a result, the operator of the Smart Grid might not be legally entitled to refuse access to the Smart Grid or decline his competitors' (and other players,' with whom he might not be interested in cooperating) requests to use the Smart Grid on an equal basis. In light of the above mentioned, it is also possible that the operator of the Smart Grids will also be required by law to allow access to such entities to the information gathered through the smart meters.

In order to ensure the maximization of the efficiency of the Smart Grid, it is highly important to apply the essential facility doctrine and to consider the Smart Gird's operator as a monopoly, so:

- The operator will be prohibited from discriminating between various electricity producers and supplier; and
- The market will be open to EESPs to offer consumers various tools efficiently use the electricity and reduce their bills.

In any event, for obvious reasons it is highly advisable that any such potential impediment, limiting the ability to reach the full potential of the Smart is removed.

Consumer Protection

The consumers of the Smart Grid are also its end-users, and therefore the Consumer Protection Law 5741-1981 will apply to the relationship between the consumers and the service provider. Accordingly, general provisions of such law and the regulations enacted thereunder shall apply in this case as well. However, there are several specific matters that in our opinion should be addressed specifically and separately.

<u>Provision of Information to the Customer</u>

The main issue in this context is the provision to the customer with detailed and clear information regarding the rates and its options as well as regarding its bills, which is important both for protecting the consumers and for enjoying the full potential of the Smart Grid.

In order to maximize the efficiency of consumption (hence fulfill the potential of the Smart Grid), consumers should be able to plan their consumption based on timely and clear information. For example, consumers should be offered lower rates at certain times. Accordingly, it is highly important that the consumers receive and understand in advance the various options and related rates.

Moreover, unlike today's fixed rates and simple method of calculation, the Smart Grid will enable suppliers or EESPs to offer consumers flexible rates and different schemes of consumption, more suitable to their actual needs (e.g. varied rates for those who mainly consume electricity in the evenings etc.). In order to enjoy such benefits, consumers should receive clear information about the alternatives.

The other important aspect is consumers' ability to easily understand their bills. In light of such complex rates and calculations (and based on our experience in matters such as bank accounts and cellular accounts), it is highly important that the bills will contain sufficiently detailed and clear information.

Indeed, such matters were already recognized and addressed in places where some sort of a Smart Grid is already operational. For example, in the United State, there are a few interesting examples of consumer oriented legislation specifically designed to deal with issues arising from the operation of the Smart Grid:

1. **Ohio**- the State of Ohio has specific consumer oriented legislation dealing with services provided by the electric grid, which provides for minimal service requirements on the part of the electricity provider. These requirements are mainly designed to ensure a reliable and clear flow of information to the consumers and include a requirement to clarify the billing method and provide a detailed account of the services rendered.[19]
2. **Florida**- due to a concern that the consumers might find reading the smart meters to be difficult, the State of Florida saw fit to obligate the electricity providers to provide their

[19] Ashley Brown and Raya Salter, *Smart Grid Issues in State Law and Regulation*, Galvin Electricity Initiative, September 17, 2010, p. 61.

customers with a detailed explanation as to the way the smart meters should be read, as well as a clarification of the billing method.[20]

3. **Texas-** Texas has state legislation which refers to utilities such as water and electricity, and determines, *inter alia*, that regarding the supply of electricity, the consumers are entitled to receive a notice from their provider concerning any possibility or right which might benefit them. In addition, the bill provides customers with complete immunity against payment requirements for services rendered without their express consent, and even determines that a basic package of the services provided by the Smart Grid must be offered to the consumers in order to ensure that they are able enjoy its basic services without incurring additional costs.[21]

Equality

While efficiency is desired, it is clear that some equality between consumers of such essential service should nevertheless be maintained, in order to ensure that nobody is deprived of such service or is required to pay unfair fees.

An example to such unfair treatment could be drawn from the case in which the authorities in Massachusetts have rejected (as unfair and contradictory to certain legal protections granted for low income consumers) an attempt to create a program that would switch low income customers from post-pay to pre-pay billing (based on smart cards), and would require them to pay premium rates for electricity used above a predetermined amount.

While we believe that the courts and the relevant authorities in Israel will regard such matters similarly to those of Massachusetts and consider them a breach of the basic right of equality, it may nevertheless be worth specifically stating such matter as part of any new legislation relating to the Smart Grid.

Tort Law - Control and Vulnerability

Many of the Smart Grid's devices can operate in a relatively autonomous manner, utilizing artificial intelligence technology to generate processes and actions with minimal human supervision and control. It is possible that some electric devices, such as a medical device

Id. at 41-42.

[21] *Id.* at 68.

connected to the Grid in a patient's home, might malfunction in the case of interruption in the electricity supply or due to unreliable network data. This type of malfunctions may bare potentially catastrophic results.

This is a significant legal risk, which may be associated with sub-standard software embedded in such devices, hardware malfunctions or external interferences. A software fault in an electric device connected to the Smart Grid significantly amplifies the already existing inherent danger posed by electric grids. For example, a defect in a software design in one device may result in that device generating erroneous data, which may be used by a "smart" electricity transmission device to make electricity routing decisions. Such "smart" electricity transmission devices on the Smart Grid can potentially enter into a "loop," oversupplying electricity to a particular segment of the Grid, ultimately causing personal injury or property damage. In such cases, it is possible that principles of tort of negligence and product liability laws can be used to hold the operator of the Smart Grid, or the supplier of the technology required for its operation, responsible for losses and damages resulting from device malfunction.

Article 35 of the Civil Wrongs Ordinance (new version) 5728-1986 (the "**Ordinance**") determines the normative basis of the tort of negligence and states:

"Where a person commits an act which, under the circumstances, a reasonable and sensible person would not, or fails to commit an act which under the circumstances a reasonable person would commit, or fails to use the proper skills or to take proper care while being engaged in any occupation in a manner a reasonable and sensible person qualified to engage in such an occupation would use or take under the circumstances, then such an act, or failure to act, is considered to be negligent; and if this negligence was in relation to another person to whom he owes a duty not to act in the manner he has acted under the circumstances, then he is considered to be negligent. Any person who, by his negligent behavior, causes damage to any other person commits a civil wrong."

This Article mentions four components, all of which must be proved to exist in order to demonstrate the tort of negligence: a damage inflicted upon the injured; a duty towards the injured; the breach of such duty; and causal relation between the breach of duty and the inflicted damage.

Firstly, the tort of negligence is constituted by both actions and omissions, which means that inaction under circumstances in which an action was warranted, might be considered to be negligent. Secondly, in order to determine the existence of negligent behavior, there has to be a provision of law which determines a duty to prevent the damage inflicted.

In Israeli case law, the term "duty," mentioned in Article 35 of the Ordinance, is divided into two distinct categories of duty: a conceptual duty of care, and a concrete duty of care. The conceptual duty of care examines the existence of such a duty between the class to which the injurer belongs, and the class to which the injured belongs. For instance, the duty of care a teacher has towards his students. The concrete duty of care examines the actions, or inaction, of the reasonable man in the shoes of the injurer under the relevant circumstances. Under the concrete duty of care, the court examines whether the injurer owes the injured party a special duty of care in relation to the actions which have taken place under the specific circumstances in which the actual damage was inflicted. Finally, it is important to mention that the examination of the components of the tort of negligence is made in accordance with the standard of reasonableness. This standard is flexible, which allows the court to adapt it to the different circumstances of particular cases. In fact, the court determines whether there was a duty of care under the circumstances and whether the injurer has violated this duty of care in a retroactive manner.

As to the causal relation, the court has determined that a negligent act must withstand the foreseeability test, which means that the duty of care towards the injured only exists when the damage is foreseeable. Only a general degree of foreseeability is required: the type of the damage inflicted has to be foreseeable, but there is no need to foresee the exact extent of the damage, as it may be argued that if the type of damage could be foreseen, then it should be foreseen that there is a chance of an extreme damage occurring. An exception to the foreseeability test is the case law-created "remoteness of damage" test, which endeavors to limit the responsibility of the injurer in cases where the damages are considered to be too far removed from the event of the injury. The literature also refers to the "thin skull" rule, which constitutes an exception to the foreseeability requirement. Adopting this rule, the case law acknowledges the injurer's responsibility for the unexpected damages which result from the pre-existing and unforeseeable weaknesses of the injured, and states that any claims on the part of the injurer with regard to the foreseeability of the damage inflicted upon the injured which were caused by a unique weakness shall be rejected, since the injurer must accept the injured as he is.

CHAPTER 5

Challenges and barriers to smart grid implementation and establishing milestones for the Israeli market

Dr. Ilan Suliman

Introduction

In the first section of this chapter, we will survey the existing barriers and obstacles to smart grid implementation abroad. In the second section, we will investigate the development of the smart grid in Israel and construct milestones based on international experience and its adaptation to the Israeli market.

1. Survey of international experience – milestones and primary obstacles

1. General

   In developing any large-scale, infrastructure-intensive field, it is necessary to set clear, measurable milestones. Prior experience in adopting smart grid policies (e.g., smart grid-compatible rate design and cost recognition, pilot project design, and large-scale interval smart-meter installations) point to significant failures in the absence of such milestones. Decisions on milestones need not be a comprehensive, integrative solution, but goal clarity and measurability must be primary characteristics of such decisions.

   In addition to these requirements for clear, measurable milestones, there are several barriers to smart-grid development that must be overcome, including:

   - Conflicting information on the influence of smart grid on public health and privacy;
   - Conservatism of electric utilities and regulators regarding introduction of the product and the need for pilots
   - Lack of coordination in the definition of terms, causing confusion among stakeholders involved in the process (regulators, equipment manufacturers, electric utilities, suppliers, and consumers);
   - Use of technologies that have yet to prove their commercial viability.

- Lack of recognition that the smart grid is only a means toward achieving policy objectives, rather than an objective. The smart grid may be considered a catalyst toward achieving energy efficiency, the environment, system reliability and security objectives, as well as other policy goals, but it is not a goal itself.

When performing international comparisons regarding smart grid implementation, it is important to be aware that there is considerable inter-country variation that significantly influences implementation policy. The variation is due to several reasons such as

- Consumption habits influencing load factor
- Percentage of renewables penetration
- Tariff policy of the utility regulator
- The characteristics of the generation sector, primarily regarding the composition of generating fuels
- The goals of decision makers regarding the smart grid.

Investigating smart grid implementation in the US and Europe indicates the main differences among the approaches and the barriers in the US relative to Europe.

In the US, most investments have emphasized encouraging start-up companies that are considered to be innovation sources. Only recently have we seen greater involvement by larger companies, mainly because of the failure of startups to make the transition independently from the development stage to the stage of integration into the electric utilities. The reason for this is that the time horizons required to make decisions in the electric utilities are too long for the average start-up company, but are a reasonable timetable for the larger communications, engineering, and VC intermediaries in the US.[22] Since 2010, the total annual investment in smart grid in the US has declined from $7 billion in 2010 to $5.1 billion in

[22] http://gigaom.com/2013/01/29/how-to-keep-innovation-alive-in-the-smart-grid/

2011 and $4.3 billion in 2012[24][23]. An investigation of the data indicates that approximately $4 billion originates from grants from the American Recovery and Reinvestment Act[25] (henceforth, "ARRA"). The main reason for this significant share of total investments by federal grants is due in part to the lack of policy coordination and consistency between the state and federal regulator. The lack of coordination and uniformity is largely in the area of rate recognition of the investment costs associated with smart grid by state-level regulators. This variation in state regulatory policy is creating uncertainty that is deterring regulated electric utilities from investing in smart grid, unless they receive preferential financing conditions from "non-rate" sources such as grants[26]. The frictions between the federal and the state regulators have also been reflected in the stagnation regarding critical transmission investments (most of whose benefits flow to consumers beyond state borders). Smart grid development has therefore become overly dependent on the "selfish" interests of state regulators and their respective constituencies regarding renewable energy and the state's benefits from trade with neighboring states, rather than on broader national policy interests.

In Europe, the level of smart meter penetration is nearly at the level reached in the US, and is likely to pass the US level by 2016.[27] The reason for this, beyond the fact that Europe has developed its smart-grid initiatives based on a transmission grid that already included some of the main components of smart grid (e.g., digital signaling systems to identify

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[23] http://www.gereports.com/top-10-countries-for-smart-grid-investment/

[24] http://www.rtcc.org/2013/03/01/smart-grid-investment-leaps-7-in-2012/

[25] Smart Grid R&D: 2010-2014 MYPP 2012Update located at http://energy.gov/sites/prod/files/SG_MYPP_2012%20Update.pdf

[26] In the US, the state regulators approve tariffs and mart rules unless the electricity transaction crosses state borders. Therefore, there is a situation by which the FERC and the Department of Energy set targets for smart grid, but the state regulator determines that the benefits from these investments in smart grid do not flow to the customers in its jurisdiction, causing the state regulator to refuse recognition of these investments in rates. In this case, the regulated electric utility must turn to FERC in order to recover recognition of these investments in tariffs that cover inter-state transactions over which FERC has jurisdiction. This phenomenon of state-federal conflict has already become a barrier to transmission construction that is essential to interstate electricity delivery.

[27] http://www.fastcoexist.com/1679148/europe-set-to-rule-the-smart-meter-world

network faults)[302928] , is the development of advanced rate structures accompanied by greater awareness by both consumers and suppliers. In France, England, and Norway, dynamic tariffs, varying according to the status of the market in real time, or within a few hours of real time, have been an increasingly relevant feature of retail electricity pricing. It is possible that an additional reason for the more rapid development of the smart grid in Europe stems from the protracted regulatory processes in the US that include lengthy hearings and expert witness testimony prior to regulatory decisions being issued, a phenomenon that does not exist to the same extent in most of Europe, and which has caused delays in progress toward a smart grid.

2. <u>California , Texas, and England</u>

The survey below shows the barriers and challenges to smart grid implementation in 2 US states (California and Texas) and 1 country (England). Smart grid integration into the transmission network has occurred either in whole or in part in these jurisdictions during the past several years. The table below shows the main points of their implementation plans.

State/country	**California**	**Texas**	**England**
Description of the smart grid plan	Full deployment of smart grid (metering, communications systems, sensors, and signals) within the jurisdiction of the California Public Utilities Commission	Gradual – smart meters and then additional smart grid infrastructure (metering, communications systems, sensors, and signals), in	Smart grid deployment in accordance with targets of the DECC regarding reduction of coal usage. The first stage was completed in 2011, but most of

[28] http://www.smartgrids.eu/documents/vision.pdf
[29] http://www.docstoc.com/docs/100311921/Enels-vision-on-Smart-Grids
[30] Powergrid International, June 2013, pp. 12-13

	("CPUC") in accordance with Senate Bill SB17.	response to the growth of intermittent renewables (wind, solar)	the deployment will occur through 2020.[31]
Obligations of the electric utility and the consumer in the plans	Annual submission of a development and compliance plan by the electric utilities for regulatory approval.	Monthly submission of a development and compliance plan by the transmission and distribution utility (plan includes meter switchouts and transmission and distribution network equipment according to a compliance timetable.	Provision of services and infrastructure according to the requirements of the RIIO mechanism (revenue, incentives, innovation, outputs)[32]. The requirements include engineering and equipment standards and system integration, as well as standards for commercial agreements and consumer protection rights.
Cost recognition in tariffs	System of cost recognition for all regulated utilities in tariffs and system of accepted cost-effectiveness tests	System of cost recognition in the tariff base according to regulator discretion and the RIIO.	System of recognition in the current base tariffs.

[31] https://www.ofgem.gov.uk/electricity/retail-market/metering/transition-smart-meters
[32] http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_INTERNATIONAL/EU-US%20Roundtable/10supthsup%20EU-US%20Roundtable/10th%20EU-US_Session%20IV_Nixon%20-%20RIIO.pdf

Statutory/regulatory timeframe	20 years (with 10-year planning horizons)	None. The integration timeframe is according to the electric utilities with the regulatory approval of the plans and progress reports	20 years
Primary focus	Achieving targets for renewables and energy efficiency	Encouraging efficient consumption and operation of electrical equipment	Achieving reductions in coal usage

3. Barriers and implementation problems in smart grid implementation in the selected states and countries

California

- **Public opposition due to concerns regarding privacy.** There is significant public concern that the communications and storage systems are not sufficiently secure to guard against transmission of data to unknown parties. These concerns have been raised during public hearings and at technical regulatory proceedings, mainly as a result of insufficient initial attention paid to issues such as: (1) ownership of energy consumption data; (2) ownership of rights to privacy protection regarding this data; (3) consumer control over transferal of data to third parties; and (4) desired procedures for protecting consumption data.[33]

- **Consumer opposition due to concerns regarding public health resulting from electromagnetic radiation.** The main concern is that continued exposure to the level of exposure from metering and communications of the smart grid will cause chronic illness, depression, dizziness, and even some forms of cancer, despite the scientific evidence of low exposure relative to cellular phone devices and prevailing environmental radiation. Nevertheless, the fact that this evidence has not yet proved to be conclusive has increased the level of opposition to smart grid development and created additional uncertainty impeding the future progress of smart grid. **Lack of coordination between the CPUC and the California Independent System Operator (CAISO).** Although the regulatory and the ISO have supported smart grid integration, their priorities for implementation differ. While the CAISO has been emphasizing the operational benefits of smart grid for dispatch, the CPUC has been emphasizing the development of smart grid for consumer benefits and enabling California to meet its energy efficiency and renewables targets. While these goals are not necessarily mutually exclusive, the difference in priorities between the CPUC and the CAISO creates unnecessary delays in smart grid development.

- **Lack of readiness and openness of the electric utilities to integrating third parties in smart grid.** The process of integrating additional supply companies in the electricity market has been time-consuming and complex. Third party integration requires coordination in two-way communications and storage systems within the systems of the dominant electric utility. In

[33] http://energy.gov/sites/prod/files/gcprod/documents/Broadband_Report_Data_Privacy_10_5.pdf

practice, however, the electric utilities have not adapted their communications systems to accommodate additional companies and have left competitive companies in a position of being secondary contractors, at best. The CPUC has also been unsuccessful in making clear decisions regarding the limits of the electric utilities in elements of the smart grid market that are not natural monopolies.

Lack of uniformity in system standards for participants in the smart grid and in methods of evaluating economic viability of smart grid investments. In the absence of common standards and uniform evaluation methods, it is difficult to make useful comparisons among electric utilities, in order to determine the most successful smart grid models and how to achieve that success.

- **Uncertainty regarding cyber security.** The implementation process has been accompanied by concerns and uncertainties regarding the level of security of computing systems and their ability to withstand challenges to that security, such as the ability to withstand attempts at security breaches and improper access/use of private consumption information.

<u>Texas</u>

- Texas has experienced identical problems to those described above in California regarding health impacts and concerns regarding consumer privacy. The main problem in smart grid implementation in Texas has been with regard to consumer privacy and this subject has been an ongoing subject for the regulator ("Public Utilities Commission of Texas" or "PUCT"). It is important to note that one of the reasons for this concern stems from the fact that there is retail competition for almost all customers, while in California there are only a few significant retail suppliers serving large commercial and industrial customers. Therefore, the concern regarding unmonitored data going to suppliers is significant. In order to provide a solution, large electricity suppliers are investing resources in quality security systems and educating consumers with regard to the personal benefits from smart grid, in their efforts to reduce remaining smart-grid opposition. Moreover, the PUCT is working primarily with the large distribution companies with the goal of creating clear, implementable standards for ensuring privacy.

- **Concern regarding public health.** This has been a concern in Texas as well, although the PUCT has given it lower priority. Although the PUCT has decided to address this topic in cooperation with the Federal Communications Commission to establish acceptable exposure standards,
- **Lack of clarity and rate recognition.** The PUCT has not adopted a rigorous set of principles for evaluating smart-grid investments for purposes of rate recognition similar to those of the California PUC. Rather, the PUCT has relied on existing policy and precedent in determining rate recognition for these investments. Consequently, determining the probability of cost recovery is more difficult than in California, although the PUCT's relatively simpler set of policy rules mitigates some of that lack of clarity.[34].

England

- **Problems of adapting technology and standardization of commercial agreements.** Although England has also experienced opposition based on concerns of health and privacy, the main problems in smart grid implementation has been the adaptation of smart grid technologies to the existing systems of various market participants and in drafting the relevant commercial agreements. This problem is especially important because of the variation existing among the 14 distribution companies with respect to commercial procedures, service territory characteristics, competitive electricity and metering suppliers, and the like.

2. **Difficulties in implementing the rate recognition mechanism.** Difficulties have arisen with regard to implementing the rate recognition of smart grid

[34] http://www.puc.texas.gov/industry/electric/reports/smartmeter/SmartMeter_RF_EMF_Health_12-14-2012.pdf

investment within the RIIO (revenue, incentives, innovation, outputs) framework by regulated distribution companies (known in the UK as distribution network operators or DNOs), necessitating wise risk management and rapid innovation[35]. Until implementation of the smart grid, the DNOs concentrated all smart grid activity and investment in their companies and received rate recognition per the RIIO mechanism. However, in the area of smart grid implementation, the DNOs must be the coordinator between technology developers, transactions between suppliers and consumers, and incentivizing investors, while also advancing goals set by the regulator per RIIO. This change has required the DNOs to create a network of management and coordination while taking responsibility for the commercial and technical risks associated with this coordination. To date, the DNOs have not yet developed the capabilities necessary to create such a network independently, contributing to implementation delays[36].**Smart grid in Israel – current status**

1. Introduction

   The Ministry of Energy and Water Resources has established that smart grid is one of four key areas in the energy field and has classified it as a top national priority[37]. At the same time, the Israel Public Utilities Authority – Electricity ("PUA") has taken a number of steps in its activities with the Israel Electric Corporation ("IEC") to improve network components, including: (a) establishing advanced data systems for automation and protection on the network; (b) installing continuous metering systems in the transmission sectors for purposes of control and information acquisition on the network; and (c) supporting the smart grid pilot project by recognizing the initiative's costs in IEC's rates. The PUA has noted that IEC estimates that it will require an investment of approximately NIS 2.9 billion just for the implementation of the initial pilot projects.[38]

[35] https://www.ofgem.gov.uk/ofgem-publications/75546/sgf-second-annual-report.pdf
[36] https://www.ofgem.gov.uk/ofgem-publications/47067/riioed1decoverview.pdf
[37] http://www.iec.co.il/ElectricityProfessionals/DocLib4/reshet%20new.pdf
[38] http://www.pua.gov.il/560-2823-he/Electricity.aspx?pos=80

2. Energy policymaking and regulation – Ministry of Energy and Water Resources ("Energy Ministry") and the PUA

In its efforts to reach its energy efficiency objectives, , the Energy Ministry has been active in promoting advanced metering and control systems[39] and integrating them into Israel's electricity system. One example of this activity has been to mandate installation of smart meters for all customers as part of the Ministry's development plan for the electricity distribution sector.

However, in order to achieve this objective, the PUA, as the independent regulator of the electricity sector, must develop the appropriate incentives, including clear principles for rate recovery of the associated costs. Although the PUA has yet to issue a comprehensive decision regarding IEC's smart grid plan (which is expected to be issued by October 2013)[40] , the PUA has claimed that the IEC plan involves high costs that have yet to be reviewed, does not provide sufficient detail regarding economic and operational parameters, and does not explain how open access principles will be preserved. The PUA proposes to establish, based on international experience, an economic viability analysis and a pilot limited to approximately 1% of consumers and establishing rules and protocols for information management. The PUA estimates that the break-even point for economic viability is achieving a 4% improvement in energy efficiency and a 10% reduction in peak loads, percentages that are difficult to achieve when, in the PUA's opinion, smart meter investment is not cost-justified for about one-third of all customers. Because of these assessments, the PUA believes that it is necessary to implement the smart grid gradually, rather than in a single step. In addition, the PUA points out the need for criteria for evaluation of smart grid projects, both at the

[39] http://energy.gov.il/English/PublicationsLibraryE/projects2012corrected.pdf

[40] צוות רשות החשמל מעריך שהרשות תפרסם החלטה עד אוקטובר 2013.

tender issuance and program analysis stages, based on accepted cost-benefit analysis principles. [41]

The PUA has set a number of objectives for smart grid implementation:

- Encouraging IEC to establish information systems for network automation and protection;
- Obtaining and validating t information on transporting energy among the network sectors through the installation of metering systems at various locations on the transmission system;
- Improvement of reliability in electricity supply and quality on the network;
- Achieving the PUA's efficiency targets (from international experience, the PUA estimates that it is possible to reduce electricity consumption by 9% and peak demand by 15%).

3. IEC

IEC defines the smart grid as "the future network based on a combination of the current electricity network with systems for communications, control, and advanced information."[42] In order to maximize smart grid benefits, IEC has established a smart grid steering committee led by IEC's Vice-President for Customer Relations. The committee brings together various activity areas in order to implement smart grid at IEC. The committee functions through an executive group responsible for preparing a road map and methodology for implementing smart grid in the company. The first stage of the committee's work was to define the goals for smart grid implementation in Israel as a whole, and particularly within IEC, including:

- Active customer involvement in the electricity market by means of demand-side management and facilitating choice for new commercial services;

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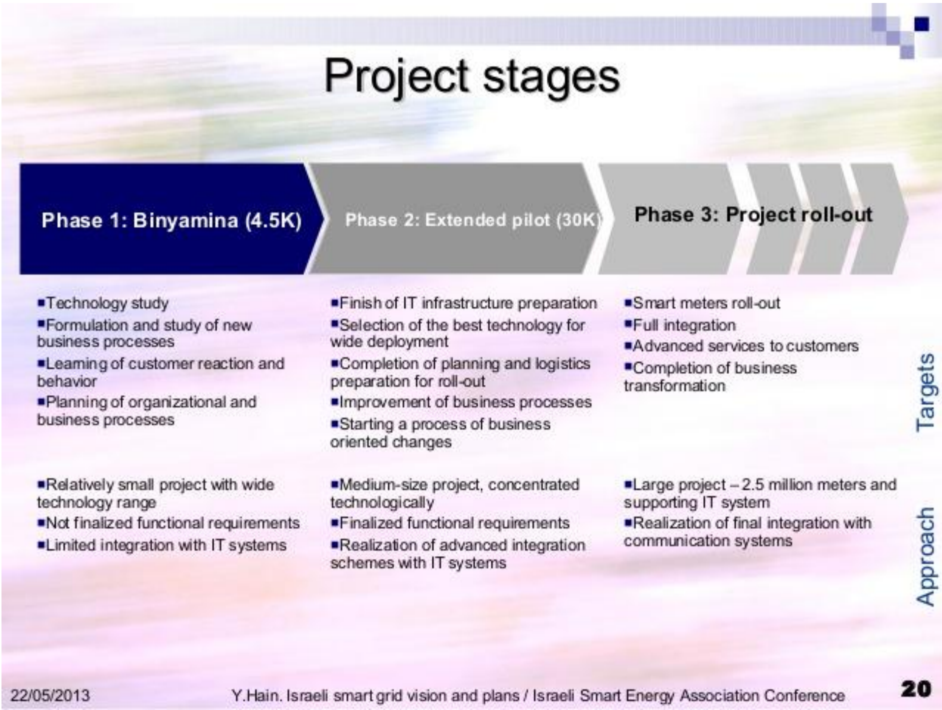
[41] http://www.pua.gov.il/560-2823-he/Electricity.aspx?pos=80
[42] http://www.iec.co.il/ElectricityProfessionals/DocLib4/reshet%20new.pdf

- Integration of renewables, electric vehicles, and future technology networks to reduce greenhouse gases;
- Development of new products, services, and markets;
- Improvement of operating and energy efficiency in the electricity market, through optimal use of infrastructure and advanced technology systems.

The exhibit below illustrates IEC's proposed staged plan for smart grid implementation:



Source: http://www.slideshare.net/IsraelExport/iec-israeli-smart-grid-vision-plans

This plan includes: (1) continuation of the current pilot taking place in Binyamina through continued use of the existing metering data system; (2) determining the approach toward cost-benefit analysis to be used both for the pilot and for wide-scale integration; (3) a tender for wide-scale integration based on lessons learned from the pilot; and (4) preparations for full-are scale integration in the system. From the plan, it is apparent that IEC is focusing its investment targets mainly in the areas of engineering, communications, improving business processes, and implementing the local-area pilot.[43]

4. Private parties

In addition to the activities of the regulator and IEC (as the main Essential Services Provider (ESP)), private companies have been active in developing initiatives focusing primarily on metering systems management, audit and control, and energy efficiency. For example, companies in the communications area are participating in tenders for communications infrastructure and support for IEC's pilot project, and are planning to expand their activities in upgrading communications between the transmission and distribution sectors through smart grid technology applications. While some of these companies are participating in IEC's "sub-pilots" and are receiving financing from IEC and Government entities, other companies have already received venture capital funding and have begun commercial operations both in Israel and abroad.

Within the framework of encouraging the private sector in developing the smart grid in Israel, the Israeli Smart Energy Association ("ISEA") was established. The goals of the ISEA include, among others, increasing awareness of the potential of smart grid, discussions with decision makers on regulatory and incentive issues, exposure of leading customers to appropriate solutions for their applications, and cooperation with similar organizations abroad.

3. Smart grid implementation – challenges and milestones

3.1 Challenges to smart grid implementation

a. **Setting agreed-upon policy among regulators regarding goals and activity means.** Promoting the smart grid in a systematic way, like other major developments in the electricity sector, involves coordination among direct regulators of the electricity market. As we have seen in the controversy regarding promoting mandatory smart metering, coordination of uniform

[43] http://www.slideshare.net/IsraelExport/iec-israeli-smart-grid-vision-plans

policy and definition of clear goals is a necessary basis for correct, rapid advancement of the process. Moreover, the coordination must extend to secondary –level regulators of the electricity sector, such as the Ministries of Environmental Protection, Communications, Economics, and Justice, and the standards-setting bodies such as the Standards Institution of Israel. As indicated above, experience abroad indicates that environment and data security issues were the main barriers to smart grid advancement. The complexity of these subjects and the fact that they cross multiple areas of regulatory jurisdiction further clarifies the need to set agreed-upon targets and policies at the systemwide level. To achieve this, designating a lead party and clearly delineating jurisdictions and areas of responsibilities is essential.

b. **Conduct and cooperation of IEC:** Currently, the Israeli electricity network is conducted mainly by IEC. The success of smart grid implementation depends on easy access to smart grid data and the audit and control system, as well as on IEC's cooperation. However, IEC's goals for smart grid development are not necessarily identical to those of the regulator, private companies, and consumers. The subject of cooperation with IEC has become even more sensitive in light of the lack of clarity regarding the direction of electricity sector reforms. There is a concern that smart grid development will be influenced by criteria related to negotiations conducted in the context of these reforms, rather than by a strict application of a cost-benefit analysis of smart grid implementation in light of various electricity sector reform scenarios. This concern must be addressed on a professional, systemwide basis by the decision maker, while minimizing partisan interests

Integrating interests while setting priorities in promoting smart grid: Continuing from the previous paragraph, promoting the smart grid embodies a much wider range of interests than the range of objectives achievable from its implementation. For IEC, the ability to manage the system while controlling activity on the electricity network is important. Private entrepreneurs, in turn, want assurances that they will be able to be integrable into the smart grid and will have access to needed information and infrastructure. The private consumer wants assurances of its ability to use the network for to improve its decisions regarding energy efficiency while ensuring that its data privacy concerns are addressed. One of the main challenges to regulators is to adopt an approach that involves the various stakeholders as much as possible, while developing a clear order of priorities in line with their policy objectives.

c. **Determining rules for ensuring data confidentiality/security:** One of the barriers abroad to smart grid rollout is the concern regarding data system security. A prominent feature of smart grid is the free flow of information regarding consumption habits circulating among a number of parties, creating concerns that use of this information may be for purposes not related to reliability, efficiency, and quality of supplying and transmitting electricity. Without a clear framework of market rules ensuring fair access and legitimate use of this information at the initial stages of smart grid design, regulators are likely to encounter strong opposition by consumers and judicial bodies that will delay smart grid rollout.

d. **Increasing consumer awareness:** The level of consumer awareness in Israel is still relatively low. Israel lacks the history/tradition of wide-scale activity in areas typical of an advanced market such as plans for intelligent electricity use, smart meter rollout, and demand-side activity. Although we have recently seen increased activity in this area, it is primarily targeted toward a limited number of customers. The result is that the lack of awareness is likely to cause a prolonged integration process that will not facilitate the creation of a consumer base sufficient to display the advantages of smart grid at a scale necessary to reduce the costs to the customer in smart grid application.

e. **Creation of coordination among technology systems:** Smart grid implementation represents a system comprised of various technologies by various generators, IEC's legacy systems, and a number of parties from various areas with various access and usage characteristics. One of the main challenges to smart grid implementation is setting market rules and standards for coordinated operations and communications, otherwise known as interoperability.

f. **Setting an updated tariff policy:** In order to fully take advantage of the benefits of smart grid integration, one essential condition is the provision to consumers and generators of the system information necessary for making economic decisions. This information must include tariffs that include a "menu" of tariff alternatives such as real-time pricing, dynamic pricing, and critical-peak pricing, among others. The current time-of-day rates and smart-consumption arrangements are insufficient for realizing the full potential of smart grid in the new era.

3.2 Milestones in Smart Grid Implementation

As a direct result of the challenges involved in implementing smart grid in Israel – some of which are unique to Israel but most of which are well-known from international experience – every smart grid implementation plan should be based on a number of basic principles beyond tests of economic viability:

A. **Defining the implementing party:** It is recommended that the committee for regulating the energy sector should address this issue, and should make a decision within the general context of the recommendations for electricity market reforms. During an interim period potentially extending over more than 6 months, smart grid implementation should be delegated to an inter-ministerial committee consisting of the Energy Ministry and the Ministry of Finance. To the extent that this committee's lead time is too long, the Ministries of Environmental Protection, Communications and the Interior should join this committee. The PUA should resolve any obstacles that might delay the implementation process.

B. **Defining priorities:** There is a wide variety of goals involved in smart grid coordination, including system reliability; intelligent demand (including tailoring rates for efficient consumption); compliance with international environmental standards; distribution of the manufacturing and storage. Given the time and budget constraints, it is impossible to achieve all the goals of smart grid implementation. Defining the main goals at the outset provides guidelines regarding areas on which to focus. It is also possible to establish a multi-year, multi-level plan in order to achieve all policy targets, but only after determining the most important goals in advance.

B1: The definition of the level of coordination among the regulator, the private sector and regulated electric companies: Such definition and coordination must be based the defined goals that have been established. In this context, the question of the extent to which a smart grid will be set up and funded by (a) the regulated electric companies according to regulator directives; (b) the government itself; or (c) private companies is extremely important. The definition of the best combination of market participants can change over time: for example, metering and information can move from the vertically-integrated electric companies to private companies with expertise in developing the relevant technology and products.

C. **Government obligation for smart grid integration in the Energy Master Plan:**

Current energy planning in Israel, in which the demand side is relatively passive and therefore not taken into account, have limited value for the future market which will include smart grid, which necessarily allows for active demand-side participation. Smart grid integration into the plan is important from the perspective of resource allocation, optimal planning, and cost-benefit analysis in providing solutions. Addressing smart grid in a manner separate from the Energy Master Plan will result in sub-optimal planning of the electricity market.

D. **Creation of a series of mechanisms to increase awareness and build consumer trust:** This issue has two dimensions: (1), consistent with global experience, assuaging concerns on the issue of data security and non-ionized radiation; and (2) educating consumers to transform themselves from being passive to assuming an active role in actively managing supply-side resources. Without such an informed base of customers, such levels of intelligent usage will not be achieved, let alone optimal levels of resource usage that should be achievable through smart grid integration.

Creation of a clear methodology for recognizing the costs involved in smart grid in electric rates: Such a methodology will ensure that smart grid initiatives are evaluated on a uniform cost-benefit basis for rate recovery purposes, and that these costs are allocated fairly among market participants.

2. Additional recommendations for promoting the smart grid

A. **Follow-up analysis:** A follow-up analysis should include data security, improved system diagnostics associated with the smart grid, business-model analyses for the purpose of making necessary changes, and a results analysis regarding compliance with national goals (e.g., operating penetration of renewable energy). The analysis should support the determination of progress toward measurable goals over time, because of the large and generally irreversible costs in setting up the smart grid. Such goals may include, for example, "to reduce peak demand by X percent from a specific baseline, within five years", while the extent of compliance with that goal would determine the percentage of the relevant costs in rates. Other goals may include decreases in greenhouse gases, employment gains, system performance enhancements, and increased customer participation as an active resource for meeting system reliability and system security goals.

B. **Identifying and enhancing areas of expertise currently found in Israel and leveraging that expertise**

C. **Establishment of dedicated funds.** Dedicated funds through electricity rates and/or Government budgets should be directed toward incentivizing promising smart grid development initiatives, including incubators to initiate new projects and technologies, and toward increased awareness of the integrated advantages of the smart grid, efficient devices and intelligent use of energy. Such funding mechanisms should be coordinated with funding sources and with the Finance and Economics Ministries, to ensure their implementation.

D. **Use of proven models from other countries in implementing cost-benefit analyses.** Utilization of the accumulated experience from abroad facilitates the identification of promising technologies and activities within a reasonable time frame. The use of such models can be part of a transparent regulatory initiative that would shorten the wait time for innovative technologies and filter out other initiatives whose benefits will not be demonstrable in a reasonable time frame.

CHAPTER 6

Cost Benefit Analysis (CBA) for Israel – Enhanced smart metering deployment

Gal Gonen and Knut Haukenes

"It ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. This coolness arises partly from fear of the opponents, who have the laws on their side, and partly from the incredulity of men, who do not readily believe in new things until they have had a long experience of them."

— Niccolò Machiavelli, *The Prince*

1. Abbreviations and terms

CBA: Cost-benefit analysis

CAPEX: Capital Expenditure

OPEX: Operational Expenditure

WAN: Wide Area Network

LAN: Local Area Network

HAN: Home Area Network

GPRS - General Packet Radio Service

IHD: In-Home Display

DLC: Direct Load Control

NPV: Net Present Value

PLC: Power Line Communication

RF: Radio Frequency

SME: Small-to-Medium Enterprises

TOU: Time of Use

CPP: Critical Peak Pricing

RTP: Real Time Pricing

BAU: Business As Usual

CML: Customer Minutes Lost

DNOs: Distribution Network Operators

O&M: Operation and Maintenance

IT: Information Technology

RES: Renewable Energy Sources

MDM: Meter Data Management

MN: Israeli Ministry of National Industries

ACEEE - American Council for an Energy-Efficient Economy

IEC: Israeli Electric Corporation

IEA: International Energy Agency

2. Introduction

The purpose of this report is to provide the first coherent, public and quantitative assessment of enhanced smart metering deployment in Israel. The current report facilitates an informed investment decision. Specifically, this report is a cost benefit analysis of enhanced smart meter deployment in Israel. Although replacing the current analog meters with smart meters is the core of this deployment, the use of the word "enhanced" points to the content of the entire system, specifically (1) smart meters, (2) communication components enabling real time, two ways communication the consumer and the infrastructure, (3) support software systems including billing system, (4) use of feedback enabling technology and (5) new and advanced tariff systems that embeds the potential of consumption pattern changes.

240 million smart meters will be installed in Europe by 2020, while the comparable number for US is 60 million (JRC and DOE, 2012). While this revolution of energy infrastructure will require large investments, there are potentially huge benefits to reap. As the benefits are critically dependent on local conditions (e.g. generation mix, load curve), a thoroughly Cost Benefit Analysis is a prerequisite for an enhanced smart meter investment. As no prior holistic financial assessment of enhanced metering has been published in Israel, this CBA is the first of its kind. Consequently, in the current report, we depend largely on international benchmarks. Once conclusions from the ongoing smart metering pilot in Binyamina are available, empirical data will replace the benchmarks. For the CBA, representing the first assessment-stage of an enhanced smart metering deployment in Israel, we encourage public feedback. Remarks and comments are welcomed.

3. Executive summary

3.1 Mission statement

The aim of this report is to facilitate an informed investment decision for enhanced smart metering in Israel. The report serves this purpose by providing a coherent assessment of the quantifiable costs and benefits related to a nation-wide enhanced smart metering deployment in

Israel. The use of the term enhanced points to the content of the entire system, specifically (1) smart meters, (2) communication components enabling real time, two ways communication the consumer and the infrastructure, (3) support software systems including billing system, (4) use of feedback enabling technology and (5) new and advanced tariff systems that embeds the potential of consumption pattern changes. With nation-wide deployment we understand (1) the household sector and (2) the small-to-medium enterprises (SME), a total of 2.54 million meter-points at the assumed start of the CBA (01.01.2015).

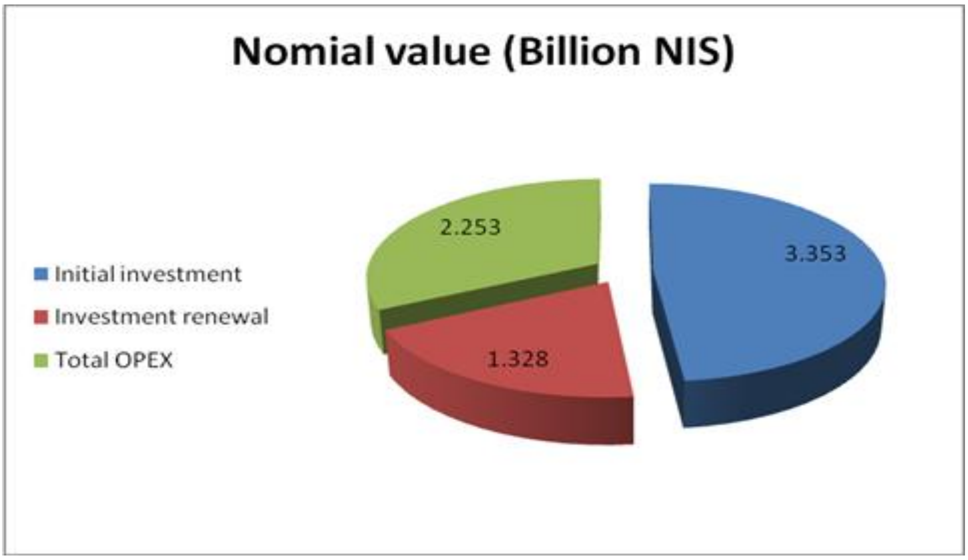
3.2 Macro assumptions and methodology

In the current report we assess (a) the incremental costs and benefits of enhanced smart metering from (b) a national point of view. An incremental analysis implies that all the costs of the business-as-usual scenario (BaU) over the horizon of the CBA will be subtracted from the costs of the enhanced smart metering deployment scenario. A national reference point implies that we calculate to what extent an investment in enhanced smart metering increases total social welfare (the size of the pie), with no reference paid to the issue of how this welfare gain is distributed (the size of each slice). To conduct the actual assessment, in lack of Israeli data, we have benchmarked costs and benefits against 20 national CBAs and more than 70 reports and research articles on pilots, technology trials and smart metering in general.

3.3 Costs of enhanced smart metering

In nominal value, the total costs of an enhanced smart metering deployment are 6.934 Billion NIS. Figure 1 displays a high level of these costs, divided into CAPEX and OPEX. Total CAPEX of enhanced smart metering is 4.681 billion NIS, sub-divided into (a) initial investment (3.353 billion NIS) and (b) investment renewal (1.328 billion NIS). Smart meters and communication is the most significant post internally (46%). Total OPEX of enhanced smart metering is 2.253 billion NIS, with data transmission as the most significant post internally (48%). CAPEX is more significant than OPEX since it includes both (a) the initial investment (3.353 billion) and (b) renewal investments (1.328 billion).

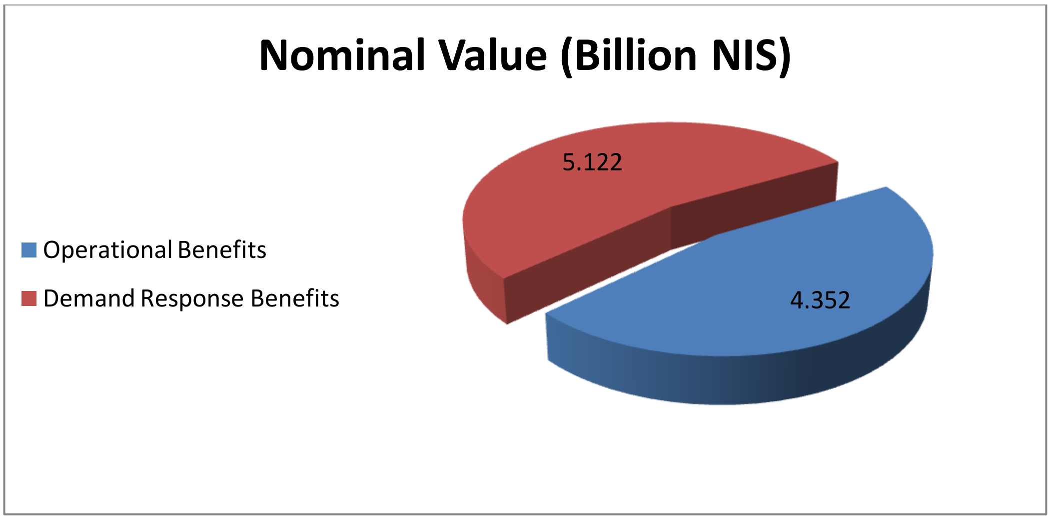
Figure 1: High level overview of CAPEX and OPEX



3.4 Benefits of enhanced smart metering

The total benefits of enhanced smart metering are 9.447 billion NIS. Figure 2 displays a high level of these benefits divided into Operational Benefits and Demand Response Benefits. Total Operational Benefits of enhanced smart metering are 4.352 billion NIS, with information benefits as the most significant post internally (47%). Total Demand Response Benefits of enhanced smart metering are 5.122 billion NIS, with consumption reduction as the most significant post internally (51%).

Figure 2: High level overview of Benefits

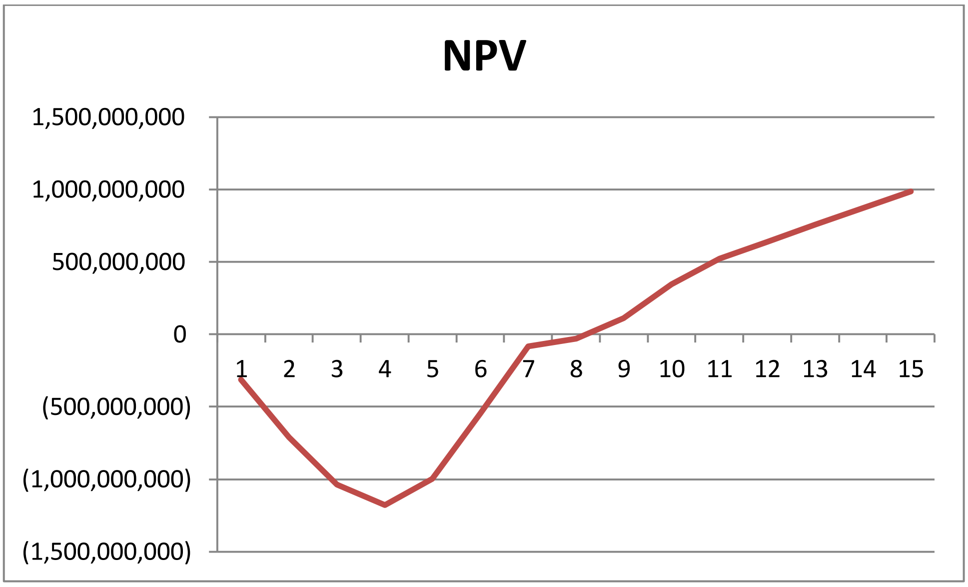


3.5 Main results

Over the 15 years time horizon of this CBA, enhanced smart metering deployment in Israel has a net benefit of 986.73 million NIS. Figure 3 displays how this NPV develops in time given the discount rate of seven percent. After the Initial IT CAPEX (407 million NIS) is completed after three and a half years, NPV shows a constant positive slope. In the fifth year there is a kink in the graph resulting from the deferring investments of a new power plant[44]. In the ninth year we get the first positive NPV.

[44] The benefit is spread over three years with a 20%, 40% and 40% distribution respectively.

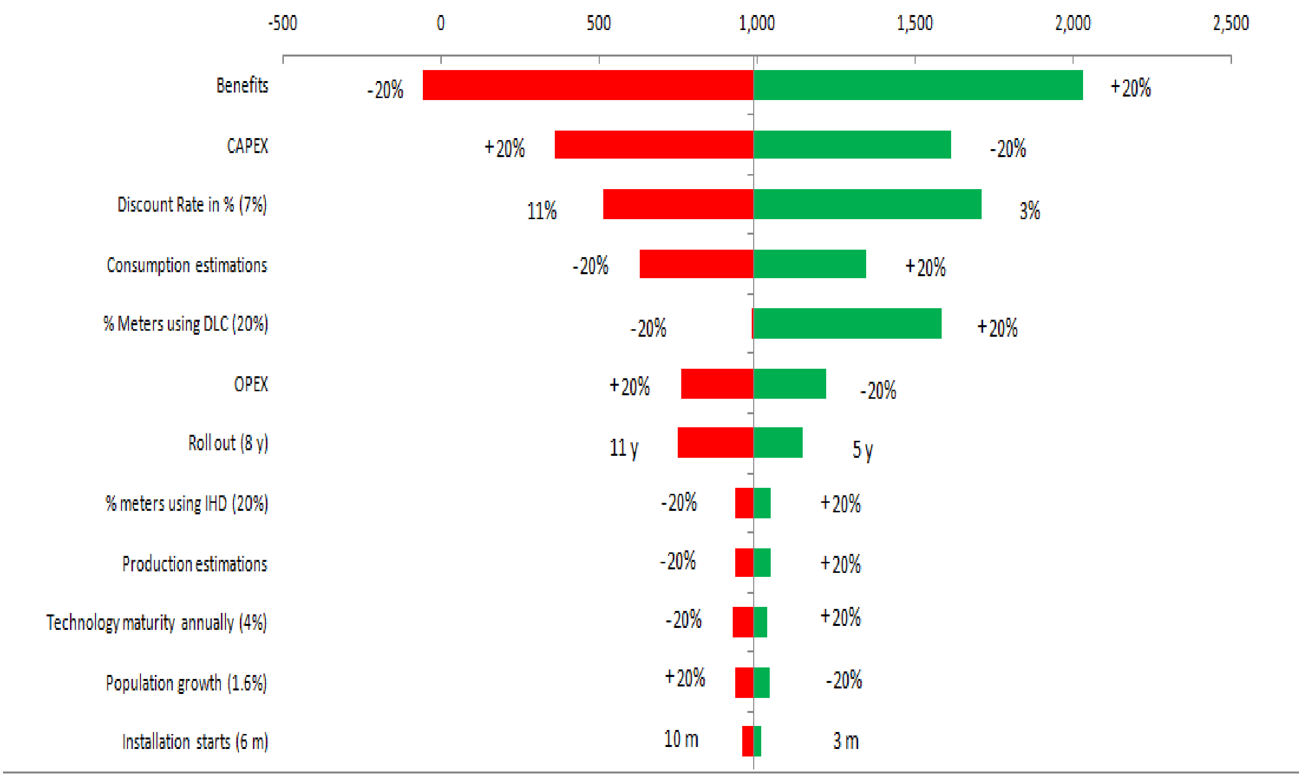
Figure 3: NPV 2015-2030 given discount rate of 7%



3.6 Sensitivity analysis.

From figure 4 we see that the NPV is most sensitive to changes in (1) benefits, (2) CAPEX, (3) discount rate and (4) consumption estimations. The positive NPV remains robust across a range of sensitivity tests carried out. A reduction in benefits of 20% is the single parameter with a potential of turning the NPV marginally negative. It is worth noting that the NPV would still be highly positive should the CAPEX of enhanced smart metering be 20% higher than what we assumed.

Figure 4: Sensitivity Analysis, changes in NPV



4. Background

4.1 Macro assumptions and methodology

This report is (a) an assessment of the incremental costs and benefits of enhanced smart metering from (b) a national point of view. An incremental analysis implies that all the costs of the business-as-usual scenario (BaU) over the horizon of the CBA will be subtracted from the costs of the enhanced smart metering deployment scenario. Consequently, on the benefit side of enhanced smart meter deployment, the BaU-costs are counted as "avoided costs" (e.g. the avoided cost of manual meter-reading) [45]. A national reference point implies that we calculate to what extent an investment in enhanced smart metering increases total social welfare (the size of the pie), with no reference paid to the politicized issue of how this welfare gain is distributed (the size of each slice). The national level of analysis also implies that tax issues are of no relevance for the model as they only represent transfer of money between groups.

45 For details on the calculation of incremental costs and benefits, see Deloitte (2011).

Since limited Israeli data is available for enhanced smart metering, we depend heavily on international benchmarks collected from national CBAs and pilots. We have included 20 CBAs from national smart meter deployments, summarized in table 1. From these 20 CBAs, we created a detailed benchmark-matrix for all the relevant costs and benefits. Additionally, we have gathered more than 70 reports and research articles on pilots, technology trials and smart metering in general. Wherever Israeli data was available, these were deployed. In the process of conducting this CBA, we collaborated closely with a range of local expertise. Consequently, several of our benchmarks findings are adjusted after local expert advice.

Table 1: Overview of global CBAs of national rollouts forming the base of our benchmark-matrix

CBAs of national roll-out read for this analysis (Electricity Only)	Europe	Other	Total
CBAs read for this analysis (in some cases more than one from each country/state)	12	9	20*
Positive result of CBA	8	7	15**
Negative Result of CBA	4	1	5***
* Netherlands, Austria, UK, Sweden, Hungary, Slovenia, France, Ireland, Germany (2), Lithuania, Denmark, Australia, Australia Victoria (2), New Zealand, US (2), Canada, US Vermont			
** Netherlands, Austria, UK, Sweden, Hungary, Slovenia, France, Ireland, Australia, Australia Victoria, US (2), US Vermont, New Zealand, Canada			
*** Germany (2), Lithuania, Denmark, Australia Victoria			

4.2 Parameters for the CBA

In this section major parameters of the CBA are presented. All the parameters are displayed in table 2, while only the controversial ones are described in detail. These are (4.2.1) inflation rate, (4.2.2) time horizon of the CBA, (4.2.3) discount rate and (4.2.4) annual technology maturity rate.

4.2.1 Inflation rate

Where general CPI is easy to extrapolate, the price of future electricity is generally hard to predict. Israel is currently undergoing a radical transformation in the energy sector with large natural gas reserves identified in the eastern Mediterranean (e.g. the Tamar-field, the Leviathan-field). In the time of writing this CBA, several questions concerning the Israeli gas adventure remain unsolved. Consequently, the future cost of generating electricity in Israel is highly uncertain. Of this reason, the CBA is conducted in fixed 2013 prices.

4.2.2 Scope of the CBA

The time scope of the CBA is 15 years. We argue that this is the appropriate assessment time based on the following three arguments: (1) the period of financial analysis recommended for other projects in the guidelines of cost-benefit analysis is no longer than 15 years (JRC,2012); (2) the lifetime/amortization-period of smart metering infrastructure is no longer than 15 years; (3) the average time horizon applied in our benchmark material is 18 years, with several CBAs arguing for 15 years as the appropriate time[46]. In this report we operate with a 10 years lifespan for smart meters and demand response technology (i.e. IHD). This is a conservative assumption since we do not reap the full benefit of this CAPEX renewal in our 15 year time horizon.

4.2.3 Discount rate

In the European guidelines for conducting smart metering CBAs it is strongly argued in favor of choosing a public policy discount rate (i.e. the lowest rate at which "society" can borrow money in the long-term, excluding short term volatilities) (JRC, 2012). Such social discount rate is preferred in several European CBAs[47]. On the contrary, if the discount rate is to give a fair reflection of the relative risk of the projects, then a higher discount rate should be applied to "smart investments" relative to conventional utility investments (JRC, 2012). From our benchmarks, the discount-rate applied in national rollouts of smart metering ranges between a lower value of 3.5 % for UK, to a higher value of 8% for Victoria and Hungary, with an average of 5.5%. In our view the appropriate discount rate should reflect macroeconomic conditions, capital constraints and risk. The risk of the enhanced smart meter investment is mitigated through customer financing, rather than private finance initiative. Customer financing is the dominating alternative in other CBAs[48]. On these grounds, we have adopted a discount rate of 7% for this CBA. The discount rate will be subjected to a sensitivity analysis for determining its effect on the net present value.

[46] See for example the Lithuanian CBA by Ernst and Young (2012).
[47] See for example the Lithuanian CBA by Ernst and Young (2012) and the UK CBA (DECC, 2013). In other parts of the world, for example the CBA from Victoria (Deloitte, 2011), the discount rate is set equal to WACC.
[48] See the German CBA (Ernst and Young, 2013) for a detailed analysis of customer financing alternatives.

4.2.4 Annual technology maturity rate

From our benchmarks, annual rate of technological progress is between 1% and 2%. From local expert advice, we operate with an annual technology maturity rate of 4%. The maturity rate is taken into account for all significant investments that occurs in a larger time-span: smart meters, communication modules, concentrators, balancing meters, in house displays (IHD) and automation devices (DLC). To the extent that 4% diverts from the literature, it should be noted that we assume a 2% maturity effect for analog meters and maintenance costs of the BaU-scenario. Consequently, due to the incremental character of the analysis, the enhanced metering maturity NPV effect is partially counterbalanced[49]. There is a strong case for including an annual OPEX cost reduction due to "learning effects"[50]. For conservative reasons, however, we have not applied such an OPEX maturity-rate in this CBA.

Table 2: General Parameters for the CBA

Parameters	Value
Inflation-Rate	Constant
Horizon CBA in years	15
Discount Rate in percent	7.00%
Annual technology maturity-rate in percent	4.00%
Annual population growth	1.60%
Exchange rate from Euro to NIS	4,8
Exchange rate from US$ to NIS	3,65
Exchange rate from LTL to NIS	1,4
Exchange rate from AUD to NIS	3,3
Exchange rate from GBP to NIS	5,7

49 Since all BaU costs are counted on the benefit-side as "avoided costs", the maturity rate of analog meters reduces the benefits of enhanced smart metering.

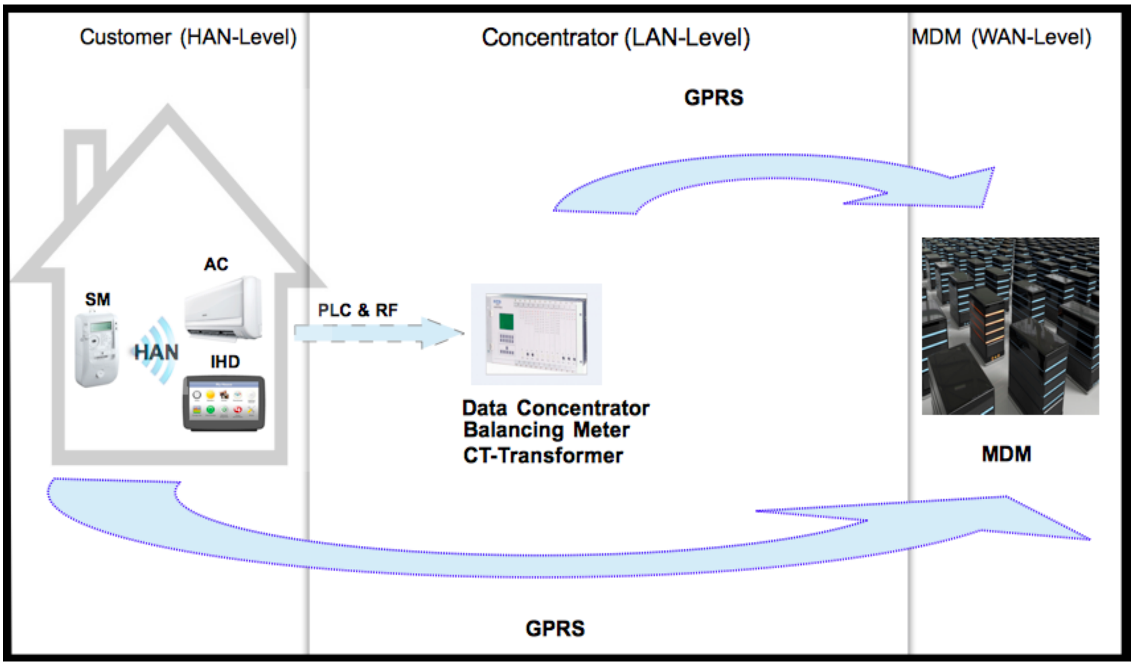
50 Se KEMA benchmark report (2012) where a 5-10% annual reduction of owning and operating the communication infrastructure is assumed.

5. Enhanced meter system

5.1 Enhanced smart metering system – the technology

Three communication-levels are covered by an enhanced smart metering system. Taking the end customer as a starting point, we have (5.1.1) the Home Area Network (HAN-Level), (5.1.2) the Local Area Network (LAN-level) and (5.1.3) the Wide Area Network (WAN-level). In figure 5 below, we have illustrated the enhanced smart metering system we assess for Israel. It is not the aim of the CBA to guide the technology choice, but we introduce a non-exhaustive list of the major technological options available.

Figure 5: Overview of enhanced metering system



5.1.1 HAN communication

The first level of communication is the Home Area Network (HAN). HAN compromises the communication between the smart meter and appliances (e.g. In Home Display (IHD) and Air Conditioner) within the household or SME. For the HAN communication, WIFI, PLC or Zigbee are the technologies used internationally.

5.1.2 LAN communication

The second level of communication is the Local Area Network (LAN). LAN is the communication between the smart meter and a data concentrator, also called “the last mile”. LAN communication is normally powered by (5.1.2.1) Power Line Communication (PLC), (5.1.2.2) Radio Frequency (RF) or (5.1.2.3) cellular-based solutions[51]. In figure 6, international deployment of the various LAN technologies is displayed.

5.1.2.1 PLC communication

PLC communication uses the low voltage power-line for two way communications between the home and a data concentrator in an existing substation. Since it requires a certain density to be cost effective, it is a communication solution for customers in urban areas, towns and villages. In Europe, there is typically one concentrator per 100- to 200 smart meters.

5.1.2.2 RF communication

RF communication is another last mile communication technology using the radio network to communicate with a concentrator. The two technologies most commonly used is the radio-mesh/multi-hop or radio star/single-hop (Neptune Technology Group, 2010). Radio-mesh involves individual meters communicating with each other before messages are passed to a concentrator. Radio star technology is simply endpoints transmitting separately to a concentrator. RF is the predominant smart metering communications technology in use in North America.

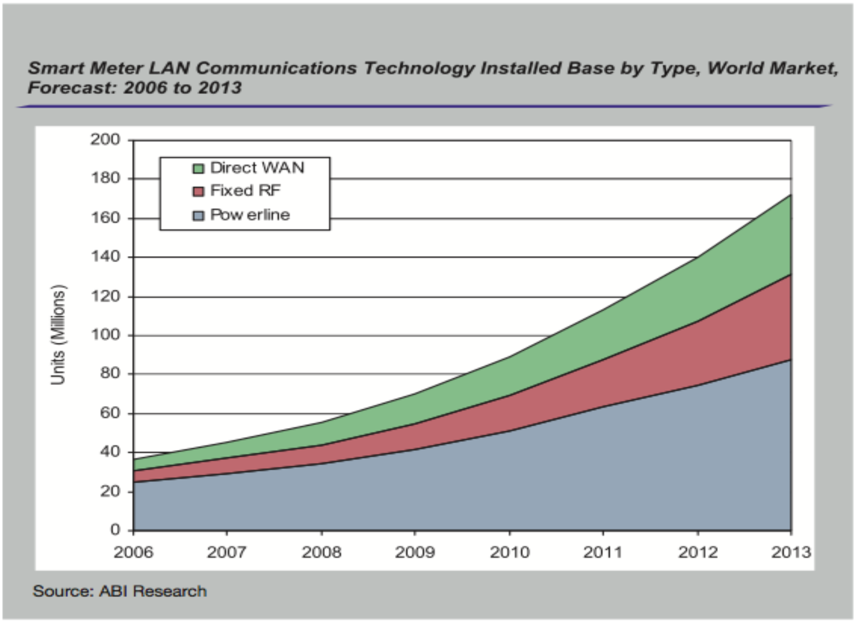
5.1.2.3 Cellular communication

Cellular-based communication has until recently been deployed as a supporting technology where neither RF nor PLC were suitable. Cellular-based smart meters do not require data concentrators as they communicate directly with the MDM over the mobile network. Cellular

[51] Cellular-based communication does not make use of data-concentrators and will consequently be LAN and WAN communication at the same time as the communication goes directly from the meter to the MDM.

solutions can be GPRS, 3G or LTE, where GPRS is favored in most cases due to lower module and transmission costs. With a recently dramatic drop in cellular module- and cellular transmission costs, these solutions are increasingly popular (ABI, 2011).

Figure 6: International deployment of LAN technology types (in millions)



5.1.3 WAN communication

The third level of communication is the Wide Area Network (WAN). WAN deals with the backhaul communication to the MDM. If the enhanced smart metering system is based on PLC or RF for the LAN-communication, WAN will represent the communication from the data concentrators back to the MDM. For enhanced smart metering, WAN communication is largely done by cellular solutions, mostly GPRS.

5.2 Enhanced smart metering system – meter functions

From broad literature the core functionalities of smart meters are identified. To identify the smart meter functionalities with highest consensus, a major study was recently conducted among European countries (European Commission, 2011). For this CBA, the smart meter functions serving as a basis for the enhanced smart meter deployment costs, and the potential realized benefits, are presented in table 3 below.

Table 3: Smart meter function-set and examples of related benefits

Function Category	Function	Examples of benefit
Remote reading	Remote meter reading	Avoided regular meter reading costs
	Remote transmission of meter status	Reduced O&M
Remote control	Remote tariff change, software update and calendar configuration	Avoided special meter visits
	Remote control of maximum permissible power	Peak Reduction
	HAN capability	Peak- and energy consumption reduction
	Remote disconnection and reconnection	Avoided costs of disconnection and reconnection
Monitoring	Fraud prevention and detection (including alarm if tampering)	Electricity theft reduction
	Grid monitoring	Faster outage response
Information	Two way communication	Avoided maintenance costs
	Saving of 15 min load sampling	Better network planning
	Record data of different parameter types (consumption data and tariff)	Facilitating detailed billing
	Data storage for at least 3 month	Avoiding billing errors
Other functions	Flexible tariffs	Electricity consumption savings
	Secure data communication, strong encryption	Consumer privacy protection
DLC	Direct Load Control	Peak Reduction
	Automation	Consumption reduction
IHD	Better information	Consumption reduction

6. The Israeli meter park – an overview

6.1 Classifying the Israeli meter-park

The CBA start date is set to 1/1/2015. Based on 2012 data, table 4 displays the extrapolated number of meters and consumption for each sector for this date. As presented, there will be 2.64 million meters at the start date of the CBA, with a total annual consumption of 67 Twh[52]. For the sake of clarity, we refer to these numbers throughout the report unless otherwise stated. This sector division of table 4 is the standard way to classify the meter-park.

Table 4: Classification of meter-points by sector

Distinction by sector	Number of meters	Consumption in annual TWh	% of total consumption in Israel
Households	2313305	21.99	32.82%
Public Commercial	276908	23.5	35.07%
Industry	35329	15.1	22.54%
Agriculture	9787	2.35	3.51%
Water Pumping	4144	4.06	6.06%
Total	**2639473**	**67.00**	**100.00%**
**Source: IEC statistical report 2012 extrapolated to 1/1/2015 values*			

For this CBA we classify the meter-points by annual Kwh consumption. The expected benefits from enhanced smart metering deployment vary mainly by consumption, not by sector. We make the distinction between end customers consuming less than 40Mwh a year (Households and Small-to-Medium Enterprises (SME)) and end customers that consumes more than 40Mwh a year (Large enterprises). An overview of this classification is provided in table 5 below. All enterprises in Israel with an annual consumption of more than 40Mwh are already equipped with smart meters and tariffed with Time Of Use (TOU). Consequently, a large part of the potential for demand-response benefits for these large enterprises is already emptied. For this reason, in the current CBA, we deal only with households and Small to Medium Enterprises

[52] Based on a population growth of 1.6% applied to each sector. The total consumption is based on numbers from ministry of energy (2013) and divided between the sectors by 2012 weights taken from IEC statistical report (2012).

(SME). Large enterprises, composing about 100.000 meters-points and 60 percent of the total consumption, are excluded from the analysis.

Table 5: Classification of meter-points by Kwh annual consumption

Distinction by KWh *	Households	Small-to Medium businesses	Large businesses	Total
Meter-points below 40Mwh	2.31 mil (33%)**	223 K (7%)		2.54 mil (40%)
Meter-points above 40Mwh			103 K (60%)	103 K (60%)
Meter-points total	2.31 mil (33%)	223 K (7%)	103 K (60%)	2.64 mil (100%)
** Source: IEC statistical report 2012 extrapolated to 1/1/2015 values*				
** Signifies percentage of total consumption of the meters-points included in the analysis				

7. Scenarios

7.1 Scenario assumptions

We operate with one scenario for enhanced smart metering deployment. A detailed overview of the assumptions guiding this "Full rollout scenario" is provided in table 6. The Business as Usual scenario (BaU), outlined in section (8.1), is the baseline in which the rollout scenario is compared to. As explained in section (4.1), costs of the BaU-scenario appear as benefits in of the full rollout scenario, taking the form of "avoided costs" (e.g. the avoided cost of manual meter-reading). In the following the assumptions of the Full rollout scenario are spelled out in detail. These assumptions are divided into three categories: (7.1.1) Meter-assumptions (7.1.2) Demand-response assumptions; (7.1.3) Rollout assumptions. The assumptions mentioned here in brief, such as opt-in rates and technology mix, are based on exhaustive argument presented at a later stage in the CBA.

7.1.1 Meter assumptions

With reference to *meter function-set*, all meters deployed are advanced smart meters. Most crucially, advanced in this context is equivalent to Home Area Network (HAN-function) in all meters deployed. This is in line with the assumptions made for the US-, the UK-, the German- and the Australian CBAs. For the *communication technology*, we model 50 percent of the smart meters as deployed with PLC and 50 percent with GPRS[53]. This is an assumption, not a recommendation or a well-funded belief about an actual deployment. It is not in the scope of this report to guide the choice of technology.

7.1.2 Demand-response assumptions

For *tariff systems*, Time Of Use (TOU) is the default option coming with the smart meter for every deployment. We assume, however, that some of the customers opt back to flat tariff (10%) and some customers shift from TOU to Real Time Pricing (RTP) (5%). We also assume that some customers will upgrade the TOU tariff with Critical Peak Pricing (CPP) (20%). Since TOU and CPP are assumed coexist, all CPP consumers are TOU consumers (see section 9.2.1.2.2 for details). With regards to *feedback type*, enhanced billing and web-portal access is the default option, coming with the smart meter for every deployment. We estimate an opt-in rate for In Home Display (20%). With reference to *Automation of appliances (DLC),* we include only automation of Air Conditioning. We estimate an opt-in rate of 20% for such Air Conditioning automation. We assume that all opt-in and opt-out rates are immediate, total and final (i.e. they do not change over time).

7.1.3 Rollout assumptions

The *rollout penetration* is limited to households and Small to Medium Enterprises (SME). For these 2.54 million end users, and the relevant population growth during the 15 years scope (1.6%), we assume 100% deployment. Large consumers, composing 103.000 meter-points consuming more than 40Mw/h annually, are excluded from the CBA for reasons elaborated in section (6.1). *The rollout time* is assumed to be 8 years, compared to a 7 years average in the European CBAs.

[53] In a NPV meter-comparison done over the timespan of the CBA, cellular (GPRS) technology turned out most expensive followed by PLC technology and lastly RF technology. From our benchmarks, the cost estimate for RF technology was the most uncertain. Being the cheapest and least reliable estimate, we omitted RF technology from the analysis.

Table 6: Assumption overview of the enhanced smart metering scenario

Main Parameters of the scenarios	Full Rollout Scenario
Tariffs*	TOU: 85%; CPP: 20%; RTP: 5%: Flat: 10%
Feedbacks	Enhanced Billing:100%; Web:100%; IHD: 20%
Meter Functionalities	Advanced meter – HAN capability
Communication Technologies	Mixed - PLC (50%) and Cellular (50%)
Automation (DLC)	20% of population
Roll-out time	8 Years
Scope of rollout	0 – 40 Mwh
* Note that TOU and CPP are assumed to coexist, so the percentage will not sum to 100.	

8. Costs – business as usual and smart meter rollout

8.1 Costs of the business as usual scenario (BaU)

In the BaU-scenario we count all the costs that are associated with running the existing meter-park. These costs will be reduced, or eliminated altogether, from an enhanced smart meter rollout. In this section we purely account for the BaU-costs, while we in section (9.1) quantify to what extent enhanced smart meter deployment reduces or eliminates these costs. Costs of the BaU-scenario are divided into (8.1.1) Analog meter visits, (8.1.2) Analog meter replacement and maintenance, (8.1.3) Customer minutes lost, (8.1.4) Technical losses in the transmission and distribution network, (8.1.5) Bad Debt, (8.1.6) Electricity Theft, (8.1.7) Call center costs, (8.1.8) Generation-expansion costs (8.1.9) Network-enforcement costs.

8.1.1 Analog meter visits

We divide analog meter visits into (a) analog meter reading, (b) analog special visits and (c) disconnection and reconnection. *Analog meter reading* is a significant cost associated with the analog meter park. All the 2.64 million meters below the 40Mwh limit are read 6 times a year. From IEC numbers, we have calculated the average reading cost per meter to be 3.33 NIS[54]. *Analog special visits* are done in addition to, and separately from regular meter-readings. IEC reports an annual average of 30.000 such special-visits. In other words, 1.2% of the analog meters are assumed to receive a special visit each year. These special visits are given a threefold rational: (a) request from customer (e.g. voltage complaints, bill disputes); (b) statistical reads (e.g. identification of drift in "families" of meters) and (c) suspicion of theft. The cost of each special visit is assumed to be 155 NIS, calculated from IEC data and benchmarked against the literature[55]. *Disconnection and reconnection* represent a third cost with the current meter-park. We assume from the benchmarks that reconnection and disconnection is offered to 1% of the population, a conservative number. Each disconnection and reconnection process is priced at 153 NIS by Public Utility Authority (PUA, 2013).

8.1.2 Analog meter replacement and maintenance

Analog meters have an average lifetime of 35 years. In procurement, analog 1-phase meters cost 57 NIS, while analog 3-phase meters costs 110 NIS. These costs were provided by IEC. The installation costs are 212- and 327 NIS respectively[56]. Every year IEC install 100.000 meters on average, roughly 4% of the existing meter park. Half of it is due to malfunctioning, half of it is due to population growth. For the CBA, we operate with an analog meter malfunctioning rate of 2% and a population growth of 1.6%. Further, we assume that (a) malfunctioning in analog meters and population growth stay at the same level throughout the scope of this CBA and (b) malfunctioning and population growth apply with the same proportion to households and SME. There are also maintenance costs associated with the analog meter-park, given by IEC to be 6.6 NIS for 1-phase meters and 9.4 NIS for 3-phase meters per year. The costs are indexed from

[54] Calculated on 2012 numbers. Based on 329 meter reading employees with a salary on cost of 160.000 NIS. 2.45 million meters are read 6 times a year, while of the 100.000 TOU-meters 90.000 are read 12 times a year (the last 10.000 are large consumers that are read remotely).

[55] In the UK CBA (DECC, 2013) special-visits are priced at 10 – 17.5 GBP depending on the specific service. While the cost assumption is somewhat lower than what we operate with, the service is assumed to be provided to 10% of the total meter park.

[56] Prices from IEC for installation where 2009 estimates and are in our CBA indexed to 2015 costs.

2009. Analog meters and maintenance are assumed to have a maturity rate of 2%, reflecting the potential for costs reductions also in the BaU scenario.

8.1.3 Customer minutes lost

CML is counted as the average of the years 2010, 2011 and 2012. The numbers are reported in the IEC financial report (2012a). Both scheduled and non-scheduled minutes are counted, and we reduce the average downwards by 10% to allow for baseline improvement. Consequently, 134 minutes of non-supplied minutes is used for the BaU-scenario in this CBA[57]. These customer minutes lost are counted per meter-point and no distinction is done between households and SME. Customer minutes lost are valued at 1.6125 NIS per minute. This is a conservative number, adjusting the value reported by Ministry of National Infrastructure (MNI, 2011) downwards by 25%[58].

8.1.4 Technical losses in the transmission and distribution network

Losses in transmission and distribution network in Israel have varied between 4-5 percent over the years 2002-2012. An average over the last 6 years of this time series, 4.2 percent, is deployed for this analysis for the BaU-scenario. Losses are valued at the current price of generation, 0.33 NIS. Note that losses are counted as 4.2% of the relevant population for the CBA, here 39.12% percent of total consumption[59].

8.1.5 Bad Debt

From the IEC financial report (IEC, 2012a), we have a total bad debt of 45 million NIS for the year 2012. We assume that 70% of this bad debt, or 31.5 million NIS, arise from households and SME. Hence, 31.5 million NIS is the bad debt BaU-scenario cost.

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[57] 149 was the average identified and we use 90% of this value for our baseline. The adjustment allows for IEC to get more efficient before the perceived start of the deployment in 2015.

[58] CML in low-voltage network was by MNI (2011) valued at 129 NIS per Kwh (2.15 NIS per minute).

[59] Since the total generation includes generation to East-Jerusalem and the Palestinian Authorities, but smart meter deployment is not assumed for these areas, their share of consumption (8%) is subtracted from total generation before the 40% is valued.

8.1.6 Electricity Theft

Electricity theft in Israel is assumed to be 0.5% of total electricity production valued at the cost of generation. The percentage of theft is an Israeli expert-evaluation found consistent with a lower bound of international benchmarks[60]. We believe, in line with the literature, that theft in Israel today occurs exclusively in the household and SME sector. Electricity theft is valued at the price of generation, namely 0.33 agorot per Kwh. Total annual electricity production at the start of the CBA, given by ministry of energy (MNI, 2013), is expected to be 72.7 Twh.

8.1.7 Call center costs

Customer enquiries and complaints generate call center costs. We have estimated, based on number of employees and other OPEX costs, annual call center costs to be 58.08 million NIS. We use this number as the BaU call center costs. It is found to be in the upper range of our benchmarks[61].

8.1.8 Generation-expansion costs

Generation expansion costs can be represented as an annual value, as done by Deloitte (2010) for Victoria[62]. In this CBA, however, we deploy a total value estimation given in a report by the Israeli Ministry of National Industries (MNI, 2010). Their calculation, based exclusively on the procurement cost of an average power-plant in Israel, is 1250 US$ (4563 NIS) per KW capacity increase. This KW cost translates into an average power-plant cost (360 MW) of 1.643 billion (MNI, 2010). The calculation of generation expansion costs mirrors the calculation of deferred generation capacity, outlined in detail in section (9.2.2.3). For establishing the base cost of generation-expansion costs over the period 2015-2030, we depend on the MNI (2013) generation forecasts.

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[60] The CBA of Ireland and Austria both operate with 0.5% of electricity theft. Other countries, like Hungary and UK, operates with levels of 1% and more.

[61] From our benchmarks, call-center costs averaged 4 euros per meter per year, or an equivalent of 48 million NIS annually for the relevant Israeli meter-park.

[19] In Victoria Australia (Oakley Greenwood, 2010), the comparative value is given by 130 AU$ per year, while in an analysis by the Brattle group of 2007 the value was 54 US$ per year.

8.1.9 Network-enforcement costs

We use data from IEC (2012a) to determine total annual network enforcement costs. From available data, over the time period 2010-2017, the average annual costs of network investments amount to 3.1 billion. For the specific period 2013-2017, according to IEC Financial Report (2012), the annual expected network expansion costs are 3.5 billion NIS. Of these 3.5 billion, 1.1 billion will be invested in transmission and 2.4 billion in distribution. We follow this prognosis and deploy 3.5 billion as our base-estimate for annual network enforcement costs.

8.2 Costs of enhanced metering deployment

Costs of smart metering are divided into two main categories; (8.2.1) CAPEX and (8.2.2) OPEX. In some reports, on the ground of functionality differences, meters supplied to SME are more expensive than meters supplied to the household sector (KEMA, 2012 and EPRI, 2011). In this CBA, however, all the meters are assumed to have the same, sophisticated functions. A difference in the average meter-price between households and SME occurs automatically as there are more three-phase meters among the SME than among the households. 3-phase meters are more expensive than 1-phase meters in both procurement and installation.

We want to underscore that it is not the aim of the CBA to guide the technology choice. In some CBAs either (a) the technology mix is fixed by expert estimation[63], or (b) technological alternatives are basis for scenario creation.[64] In other CBAs, a CAPEX and OPEX estimate is given without details about technology choice.[65] In this CBA we follow the last model, basing our CAPEX and OPEX estimates on an average technology-mix cost. We have, however, done a full cost estimation of all the technology types to (a) provide a model for such a technology assessment in the future, and (b) be explicit about the base of our estimations.

In this section, and in the benefit section that follows (section 9), we present in detail how we reach to each individual estimate, while the result part (section 10) aggregates all the individual parts into a high-level cost- and benefit calculation.

[63] See for example the Lithuanian CBA (E&Y, 2012) and the Austrian CBA (PWC, 2010).

[64] See for example the Irish CBA (CER,2011a)

[65] See for example the Hungarian CBA (Force Motrice and ATKEARNEY, 2010)

8.2.1 CAPEX

In this section we deal with the individual parts of enhanced smart metering CAPEX. From a macro perspective, a distinction is deployed between "CAPEX" and "CAPEX renewal". Brief, the former is initial required investment while the latter is refresh costs in the end of a technologies' lifecycle[66]. From a micro perspective, CAPEX is divided into (8.2.1.1) Smart meter costs, (8.2.1.2) Communication equipment costs, (8.2.1.3) IT-system costs, (8.2.1.4) Demand response component costs and (8.2.1.5) Unexpected costs. Renewal costs are not singled out, but rather included under the relevant section.

8.2.1.1 Smart meter costs – meter types and installation

In our benchmark overview, across relevant communication technologies and meter-phases, unit-prices vary between a low 264 NIS for single-phase PLC-meters in Hungary (Atkearney and Force Motrice, 2010), and 662 NIS for GPRS three-phase meters in Lithuania (E&Y, 2011). The average unit-price in our benchmarks is 370 NIS. This is the same cost-scope found in pilots across the world by the KEMA benchmark-report (2012). The large price gap is largely due to functional differences of the meter. For the relevant meter functionalities considered in this CBA (see table 3), the Lithuanian CBA (E&Y, 2012) and the Irish CBA (CER, 2011) provides detailed cost estimates. Table 7 displays the average price of the two CBAs by communication technology and meter-phases.

Table 7: Smart meter costs in Ireland and Lithuania without HAN-module

Smart Meter*	Single Phase, Price NIS	Three Phase, Price NIS
Smart Meter with PLC communication	338	502
Smart Meter with GPRS communication	504	595
Data from CBA Lithuania (E&Y, 2012) and CBA Ireland (CER, 2011). Costs without HAN		

[66] For model purposes they are treated as equal, while the practical implication is that CAPEX renewal can be postponed to a certain extent.

The costs in Table 7 are found to represent an upper-, middle ground of the larger benchmark-matrix. The cost differences between the meter types are also reasonable[67]. Thus the meter prices above, HAN excluded, are deployed for this CBA. We assume installation costs for smart meters to be 150 NIS for one-phase meters and 232 NIS for three-phase meters. The cost difference is based on the current meter-installation costs provided by IEC, and the estimation is the average of what is found in the European CBAs[68].

The rollout of smart meters is assumed to take 8 years, and the actual deployment is initialized six month after the start date of the CBA[69]. This delay is included to facilitate project planning and initial build-up of the MDM system. The deployment is modeled to be proportional in time and between sectors so (a) the same amount of smart meters are installed every year and (b) the same proportion of smart meters are changed for both households and SME every year[70]. We do not include the potential NPV effect of a strategic deployment – i.e. that an actual rollout could give initially higher than average benefits and lower than average costs (by deploying in high consuming, densely populated areas). By assumption, no analog meter will be deployed from the start of the CBA. Consequently the rollout scenario accounts for population growth and analog meter malfunctioning.

For conservative reasons, we assume the lifetime of smart meters to be 10 years. This is significantly lower than the 15 years consensus deployed globally for a variety of CBAs, and it also counters empirical observations (KEMA, 2012). The re-deployment starts in the 126th month, and follows the pattern of the initial enrollment at a rate of 90%[71]. It is important to note that, in a lifetime perspective, the benefits of this re-investment for the years 16-20 are not quantified by this CBA as the time scope is only 15 years. Hence, the benefits of this CAPEX renewal are significantly understated.

<u>8.2.1.2 Communication equipment costs – concentrator, balancing meter and CT-transformer</u>

[67] From the German CBA (E&Y,2013) and the Austrian CBA (PWC,2010), the GPRS meter should cost around 100 NIS more than the PLC meter due to communication module price differences. From the KEMA (2012) benchmarks, GPRS meters are expected to costs 168-240 NIS more than PLC meters. Our numbers are in the upper line of the German numbers, but in the lower line of the KEMA numbers.

[68] Benchmark average 190 NIS, ranging from 50 NIS in Lithuania to 300 NIS in Denmark.

[69] We do not quantify stranded costs, i.e. the cost of replacing analog meters before the end of their economic lifetime (JRC, 2012).

[70] The opportunity of postponing or delaying some investment, with a potentially positive effect on NPV, is not included.

[71] In other words, 10% less meters are installed in every moth of the re-deployment compared to the initial deployment. The reduction is explained by the annual replacement of 0.5% due to malfunctioning.

As outlined in section (5.1.2.1), PLC is a last mile communication. Hence a data-concentrator is needed for backhaul communication. We assume that a concentrator will be installed in every distribution transformer[72]. In 2012 numbers, there were 45.868 distribution transformers in Israel, giving a ratio of meter per concentrator of 53:1 for the 2.46 million meters the same year (IEC, 2012a, large consumers excluded). Extrapolated to 1/1/2015, we assume this ratio to be constant around 50:1[73]. As there will be several instances where this rate cannot be obtained (e.g. geographical factors), we assume an inefficiency reduction of 5%. In line with the Lithuanian CBA (E&Y, 2012), and from IEC information, each concentrator will have a balancing meter and a current transformer[74]. Balancing meters records the quantity of electricity being transmitted to the corresponding transformer station. The only CBA that clearly distinguishes between the CAPEX of concentrators and balancing meters is the Lithuanian CBA by Ernst and Young (2012). They operate with a total CAPEX (procuration and installation) of 3200- and 4640 NIS for concentrators and balancing meters respectively. We use these cost estimated for our CBA as they are in line with broader benchmarks[75]. We do not account for any renewal costs for communication equipment in the scope of the CBA.

8.2.1.3 Demand response technology costs – HAN, IHD and DLC

Every meter point is assumed to be deployed with HAN. The cost of the HAN module varies from a low range of 11 NIS in the UK CBA (2013), to a high range of 48-72 NIS provided by the Lithuanian CBA (E&Y,2012) and the Irish CBA (CER,2011). An even higher estimate is given for the case of New Zealand[76] (Nzier, 2009). In the current report, we assumed a HAN module cost of 60 NIS. In table 8 below, meter prices are given included HAN.

In Home Display (IHD) has a price range of 80 to 240 NIS in our CBA-matrix. The average over 8 CBAs is 160 NIS. We adopt this average value for the current CBA since it is found to be in line with the most recent estimate available, the German CBA by Ernst and Young (2013). The

[72] This is the general assumption (see for example the Lithuanian CBA (E&Y,2012) and it is confirmed by IEC as the way PLC would be installed in Israel.

[73] In the benchmarks, the range is from 44-200 with an average of 126.

[74] In line with the Lithuanian CBA we do not provide a separate estimate for the current transformer but rather bake it into the price of concentrator and balancing meter cost.

[75] From our benchmark matrix, a PLC concentrator has an average cost of 3900 NIS. In the benchmark report of KEMA (2012) the cost range is 1680 – 3360. From these benchmarks, however, it is not clear whether the cost reported includes balancing meters or not.

[76] For New Zealand the estimate is 200 NIS, but this includes installation and is modeled as a retrofit of existing meters.

installation costs of IHD are rarely singled out in the CBAs. KEMA (2012), in a reliable and highly cited benchmark report based on pilot results, estimates the IHD installation costs to be in the range of 38 – 120 NIS. This range is adopted for Germany as well (E&Y, 2013). For this CBA we adopt a higher range estimate of 100 NIS for the CBA.

The costs of automation, or more specifically DLC, are not standardized to the same degree as IHD[77]. The cost-effectiveness for mass distribution of automation technologies is tightly linked to air condition saturation, thus it has not been a relevant benefit for most European CBAs[78]. Benchmarks are mainly available from New-Zealand, Australia and the US. In the US, the Brattle Group et. al. (2009) operates with an estimate of 730 NIS[79] for the total cost of a DLC device with installation and 15% up-front OPEX included. In a detailed Australian cost estimation, the unit-cost of DLC ranges between 270- and 335 NIS, with an installation cost of 250 NIS[80] (NERA, 2008). We opt for a middle ground cost estimate of 300 NIS per DLC device and 250 NIS per installation.

The lifetime cycle of IHD and the automation device is assumed to mirror that of smart meters. Hence, a CAPEX renewal at 90% rate of initial CAPEX is assumed from the 126th month. Note also that for all the costs above, meters, communication equipment and demand response technology, we assume a technology maturity rate of 4%. Its justification is elaborated in section (4.2.4).

8.2.1.4 IT-systems CAPEX – MDM and web page

The centralized IT-center for storing and managing all the data from the smart metering system is named the Meter Data Management system (MDM). The MDM system is ensuring that metering data is safe, verified and easily accessible. Regarding the total CAPEX of the MDM, there is a large variety in the available benchmarks, ranging from 21 NIS per meter point in Lithuania (E&Y, 2012) to 921 NIS per meter point in Australia Victoria (Deloitte, 2011)[81]. Excluding these two extremes and looking at the average range identified in UK (134 NIS), Austria (47.5 NIS) and Ireland (54 NIS) gives us an average value of 79 NIS per meter. For 2.54 million meter-points

[77] Automation technology is the broad category for all sort of home appliance automation. We refer to DLC and automation interchangeably.
[78] In the Brattle Group et al. (2009) analysis of US potential, automation-potential is measured exclusively on the ground of air conditioner saturation.
[79] NIS to US $ 3.65
[80] NIS to Australian Dollars 3.35
[81] All the estimates include MDM set-up for an advanced meter function-set

that gives a total investment of approximately 200 million NIS[82]. An expert estimation for Israel, given the services enhanced smart metering will supply, is 100 million US$ (365 million NIS). Though higher than what has been suggested in Europe, we have deployed 365 million NIS for this CBA. The complete MDM-CAPEX will occur over the first 3 years of the rollout.

A Web Portal will be offered to all end customers with online direct and secure access to all their detailed consumption data. The details of the portal have yet to be decided, and the costs will evidently vary with functionality. For the total investment, the Irish CBA (CER, 2012), has quantified a range from 1.31 – 17.45 NIS per meter-point, deploying 4.32 NIS for the actual CBA. In the Austrian CBA (PWC, 2010), the web-portal is quantified to 15 NIS per meter-point. To allow for an extensive function-set, we use the upper estimate of 17 NIS per meter-point for the current CBA, resulting in a total investment of 41.8 million NIS[83]. Also this investment will occur over the first 3 years of the rollout.

For the total IT-CAPEX, MDM and the Web-portal, the literature, operates with an amortization period of 7-8 years[84]. In our model, we have included an annual recurrent investment to allow for replacing and upgrading IT equipment. We refer to this recurrent investment as IT CAPEX renewal. Starting 2 years after the IT-system installations are finalized, we assume a CAPEX renewal at 10% of the relevant IT-CAPEX[85]. This implies that, during the time scope of the CBA, we invest twice in MDM and web-page. The assumption is in line with international benchmarks and local expert estimations[86].

8.2.1.5 Unexpected costs

Unexpected costs are largely related to exchange rate risks, exchanging fees and hedging. Such costs are included both from the CAPEX- and the OPEX-side separately. From the CAPEX-side, we have determined unexpected costs to be 8% of total CAPEX. This cost is not benchmarked, but included after local expert recommendation.

[82] The UK estimate includes OPEX of running the MDM-system.
[83] Calculated on 2012 number of meter-points (IEC, 2012b).
[84] See the Victorian CBA (Deloitte, 2011) and the German CBA (E&Y, 2013).
[85] The CAPEX renewal for MDM and Web-Page is of their own relative CAPEX, not total CAPEX.
[86] In the Lithuanian CBA (E&Y, 2012), total running costs of IT are lumped together under the name “IT O&M”, valued at 23% of total CAPEX annually. We have separated what we define as CAPEX on one hand (Renewal CAPEX) and OPEX on the other hand (Annual IT maintenance costs).

Table 8: Overview of CAPEX for enhanced smart metering

Smart Meter Included HAN	One-Phase (Price NIS)	Three-Phase (Price NIS)
PLC-Meter	398	562
Cellular-Meter	564	655
Installation	150	232
Communication Equipment Included Installation	**PLC**	
Balancing Meter	4640	
Data Concentrator	3200	
Demand Response	**Price NIS**	
IHD	160	
IHD Installation	100	
DLC	300	
DLC Installation	250	
IT – Costs	**Price NIS**	
IT-systems	365 mill	
Web-Portal	41.8 mill	
IT recurrent annual investment	10% of relevant IT CAPEX (MDM, Web-Portal)	
Other	**In percent**	
Unexpected costs (e.g. exchange rate risk) of total CAPEX	8% of CAPEX	

8.2.2 OPEX

Under OPEX we treat (8.2.2.1) Ongoing replacement costs, (8.2.2.2) Ongoing maintenance costs, (8.2.2.3) Ongoing data transmission costs, (8.2.2.4) Ongoing IT-system cost, (8.2.2.5) Ongoing financial and legal costs, (8.2.2.6) Unexpected costs and (8.2.2.7) Other OPEX costs. An overview of OPEX costs is given in table 9.

8.2.2.1 Ongoing replacement costs

We assume smart meter malfunctioning to be 0.5% per annum for all meter-types. This is confirmed by IEC from current smart meters, and it is in line with international benchmarks. When any technology malfunctions, it will be replaced. Further, we assume that PLC concentrators malfunction at a rate of 1.5% per annum. This is benchmarked from an extensive technology trial recently executed in Ireland (CER, 2011a)[87]. For the IHD and the DLC, we deploy an annual malfunctioning rate of 1.5% and 1% respectively (CER, 2011a).

8.2.2.2 Ongoing operation and maintenance costs

Apart from malfunctioning, there are other ongoing operation and maintenance costs associated with an enhanced smart metering park. From our benchmarks, these O&M costs are assumed to be higher in the beginning when the smart meters are recently installed[88]. Re-visits in the installation process and better routines (increased efficiency) are possible explanations of falling O&M costs. Higher initial costs are confirmed with the IEC and local expertise. With time, O&M costs are assumed to be more or less stable and can be represented by a constant malfunctioning percentage[89]. In sum, O&M costs are given an average, annual weight of 0.5%, with higher initially, gradually decreasing impact[90]. Reduced electricity consumption of the meter itself, though potentially a huge benefit of smart metering deployment, is not accounted for in this CBA[91].

8.2.2.3 Ongoing data transmission costs

Date transmission costs vary with (a) the type of communication technology, (b) the functionalities of the meter, (c) the tariff scheme deployed and (d) the penetration-rate of each technology. For cellular transmission costs, several sources expect the costs to be at around 22 NIS per meter per year with full scale cellular deployment (ABI research 2011 and UK CBA 2013). In our benchmark matrix, GPRS costs vary from a low estimation of 30 NIS for UK (CBA

[87] A higher malfunctioning rate for concentrators than smart meters is confirmed by the CBA from Vermont (Friedman Sullivan & Co, 2007)

[88] This is confirmed by the Italian case where OPEX costs per meter have been reduced by 40% over the 9-years period 2001-2010 (Ilario Tito & Laura Panella, 2012).

[89] Most CBAs ignore this initial higher cost and assume a constant replacement rate of 0,5%-2%, as the only operation and maintenance cost (CER,2011a; E&Y,2012)

[90] For simplicity, O&M is modelled as malfunctioning of the relevant technology (e.g. smart meter, IHD). In the 15 years time scope, O&M is weighted 2% the first two years and 0.27% the resting years to give a total average of 0.5%.

[91] In the Lithuanian CBA, Ernst and Young (2011), savings of analog meter electricity costs was the most significant operational benefit.

2013) to a high estimation of 120 NIS for Germany (E&Y, 2013), with an average of 44 NIS. We adopt the average value of 44 NIS per meter per year for GPRS meters.

From the benchmarks, the annual per-meter communication cost for PLC is reported to be in the range of 5%-40% of pure cellular meter communication costs[92]. Annual, per meter communication costs for PLC ranges from 2.4 NIS in Lithuania (E&Y, 2012) to 48 NIS in Germany (E&Y, 2013). We determine the annual communication cost per PLC as a function of the cellular communication costs, valued as 20% of the cellular cost – i.e. 9 NIS per year.

Finally, we also add a communication cost for HAN. In the German CBA (E&Y, 2013), HAN is given an OPEX costs of 16.8 NIS per meter per year. As no other CBA includes this cost, and the German estimates for communication costs constantly are more than double than all other CBAs, we correct for this by deploying a cost of 8 NIS per HAN module per year.

8.2.2.4 Ongoing IT costs – management, software and maintenance

Annually IT operational costs are assumed to be 15% of total initial IT CAPEX – i.e. MDM and Web-portal. Firstly, this cost represents the management costs of the total IT-infrastructure, particularly the costs of big data analysis. Secondly, it includes the cost of software-updates and general maintenance. The estimate of 15% is benchmarked from the literature and subjected to local expertise[93].

8.2.2.5 Ongoing financial and legal costs

Ongoing financial costs are the costs of issuing guarantees, borrowing money and various fees. Financing costs are valued at 3% of the total CAPEX from the start of the model until the rollout is completed – i.e. after eight years and six months. To be conservative, the full financing cost is assumed to materialize in the first month of the CBA. Ongoing financial costs are not benchmarked but were included after local expert recommendation. *Provision to legal lawsuits* is included exclusively to cover actual property damage during deployment (e.g. power lines, phone lines). Again, from a national perspective, we have no concern for money transfers. We assume that provision to legal lawsuits will be 0.5% of annual CAPEX during the rollout.

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[92] Some price ratios in Euros where 5: 20 (Flanders by Leuven,2007); 1,5:9 (Flanders by Tahon et Al 2012); 10:25 (Germany by E&Y 2013); 10:1,14 (Ireland by CER 2011a) and 10,5:0,5 (Lithuania by E&Y 2013)

93 A "thumb-rule" of 15% is applied by Ernst and Young (2013) for the German CBA. The same OPEX was applied in the Austrian CBA by PwC (2010). In the UK CBA by DECC (2013), 15% was the starting number gradually declining to 5%.

8.2.2.6 Unexpected OPEX

Like for CAPEX, unexpected costs are largely related to exchange rate risks, exchanging fees and hedging. From the OPEX-side, we have determined unexpected costs to be 5% of total OPEX. This cost is not benchmarked, but included after local expert recommendation.

8.2.2.7 Other OPEX costs – publicity, project management

We have counted two other OPEX costs. *Firstly, publicity and education costs.* These are grouped together and spread evenly over the rollout period of 8 years and six month. The cost is benchmarked as a per-meter cost. Internationally the range is from 3.56 – 5.5 NIS per meter-point in total value, so a middle ground estimation of 4.5 NIS per meter is adopted for this CBA. *Secondly, total project management costs.* These are assumed to be 1% of the total CAPEX cost in total value[94]. Project management costs are modeled to start from the first month and last until the smart meter rollout is completed. The costs are divided equally over the eight years and six month assumed for the initial rollout to finalize.

94 Same value as deployed by Ernst and Young (2011) for the Lithuanian CBA.

Table 9: Overview of OPEX for enhanced smart metering.

Smart Meters	PLC	Cellular
Annual communication cost in NIS per meter*	9	44
Annual communication costs HAN in NIS per meter	8	8
Annual replacement rate in percent	0.50%	0.50%
Annual O&M-costs represented as malfunctioning in percent	0.50%	0.50%
Communication Equipment (concentrators and balancing meters)	**PLC**	**Cellular**
Replacement rate in percent	1.50%	n.a.
Annual O&M-costs represented as malfunctioning in percent	0.50%	n.a.
Demand Response	**IHD**	**DLC**
Replacement rate in percent	1.50%	1.00%
Annual O&M-costs represented as malfunctioning in percent	0.50%	0.50%
IT-systems operation and management costs	**Annually**	
Annually total IT O&M costs in percent of total IT-CAPEX (MDM and Web-page)	15.00%	
Financial and legal costs	**Total Value**	
Financial OPEX in percent of total CAPEX (during rollout)	3.00%	
Provision to legal lawsuits in percent of annual CAPEX	0.50%	
Unexpected OPEX	**In percent**	
Unexpected costs (e.g. exchange rate risk) of total CAPEX	5.00%	
Other	**Only during rollout**	
Publicity and Education costs in NIS per smart meter deployed	4,5 NIS	
Project Management costs in percent of total CAPEX	1.00%	

*Communication-costs for PLC represents data-transmission costs from the concentrator to the MDM divided per meter-point, while for cellular it represents the data-transmission directly from the meter-point to the MDM.

9. Benefits – Operational benefits and Demand-Response

9.1 Operational Benefits

Operational benefits arise from reducing, or for some variables eliminating in total, the costs of the business as usual scenario. The BaU base-numbers for this reduction, i.e. the costs of the BaU-scenario, are described in detail under section (8.1) and will not be repeated here. Operational benefits can be benchmarked without contextual adjustment as they are tightly linked to the enhanced smart metering technology (e.g. avoiding manual meter reading). From the literature, operational benefits are expected to cover somewhere between 50%-80% of the total smart metering investment (i.e. total CAPEX) depending on the context[95]. In this section we present the benchmarked assumption for each operational benefit together with its total nominal value over the scope of the CBA (i.e. 15 years). Where direct benchmarks are available, we break down the benefits to per-meter value to facilitate comparison[96]. Operational benefits are given the following fourfold structure: (9.1.1) Remote reading benefits, (9.1.2) Increased information benefits, (9.1.3) Better billing benefits and (9.1.4) Other operational benefits.

9.1.1 Remote reading - reduced field service management benefits

From the literature, we have identified two benefits under the umbrella term of reduced field service management. This cluster of benefits arrives from the meter-function of remote meter reading and remote control over the meter. In the following we treat (9.1.1.1) avoided meter reading and meter visit costs, and (9.1.1.2) avoided costs of disconnection and reconnection.

9.1.1.1 Avoided meter reading and meter visit costs

Since smart meters are read remotely, enhanced smart meter rollout eliminates the costs of analog meter reading. The nominal benefit of avoided meter-reading over the time scope of the CBA is 632 million NIS, or 16.6 NIS per meter per year. This value is in the mid-range of what we

[95] See Ahmad Faruqui, Dan Harris, and Ryan Hledik, (2009)
[96] Note that the comparison should be taken as a "ballpark" rather than exact value as the per-meter values differ in how they are calculated. To arrive at our per-meter-value, number of meter-points 1/1/2015 is used (2.54 million).

identified in our benchmarks[97]. For special visits, however, we do not assume that these will be avoided, but reduced. It is reasonable to assume, in line with the UK CBA (2013), that also smart meters require special visits, though to a lesser extent than analog meters[98]. In sum, taking a conservative approach, we assume that the total cost of BaU special visits will be reduced by 80% with the deployment of enhanced smart metering[99]. The 80% reduction of special meter-visit costs translates into total nominal value of 565 million NIS over the scope of the CBA.

9.1.1.2 Avoided costs of disconnection and reconnection.

One of the smart meter functions specified for this CBA is remote connection and disconnection of electricity supply to a customer unable to pay the electricity bill. The BaU-cost of physical, on sight disconnection and reconnection is elaborated in section (8.1.1). With remote disconnection and reconnection this cost will be eliminated altogether, at a total nominal benefit of 48 million NIS over the scope of the CBA.

9.1.2 Increased information – network optimization benefits

Network optimization benefits occur due to the function of interval reading providing the benefit of increased and more precise information. Better information, again, is assumed to reduce: (9.1.2.1) network enforcement investments, (9.1.2.2) transmission and distribution losses, (9.1.2.3 customer minutes lost and (9.1.2.4) electricity theft.

9.1.2.1. Reduction in network enforcement investments due to better planning

Detailed, continuously historical data of power flow, grid connection, voltage and maximum loads will guide new network investment as well as network enforcement more precisely. By greatly easing the identification of bottlenecks, investments will be directed towards the critical parts of the network. There is consensus in the literature on these effects, but lack of consensus towards how to quantify them. The UK CBA (2013) is the only report presenting a precise estimate, placing the value at 5% reduction of total,

97 Average from out benchmarks was 2.64 Euros per meter per year with a range from 0.3 (Lithuania) – 6 (UK).
98 In the UK CBA (DECC, 2013) these special visits are referred to as "special safety inspection visits".
99 In the UK CBA, the total cost reduction is assumed to be 90% of initial costs.

required network enforcement investments. Large investments in the Israeli distribution network will occur irrespectively of an enhanced smart meter deployment. Smart metering deployment would, however, be helpful in directing future investment prioritization. In sum, we adopt a conservative estimation of 2.5 % for network enforcement investment reduction. As planning by nature is a long run activity, we assume the benefit to initialize only after 50% of the smart meters are deployed. Over the scope of the CBA, the total benefit of better planning is 856 million NIS.

9.1.2.2 Reduction in transmission and distribution losses

Identification of where losses occur, and to what extent, is the key to its reduction. Again increased access to information is the driver, so a significant regional coverage will have to be in place before any effect materializes. We assume the critical point to be 40% deployment. In the Hungarian CBA by Atkearney and Force Motrice (2010), a total reduction of 20% is assumed for electricity. In the Lithuanian CBA (E&Y, 2012), the reduction is estimated to be 50%[100]. In consultation with local expertise, 10% reduction is deployed in the current CBA. Note that the reduction of losses is calculated from the total consumption of the relevant population – i.e. households and SME. A conservative 10% reduction in transmission and distribution losses gives a total benefit of 540 million NIS over the scope of the CBA.

9.1.2.3 Reduction customer minutes lost

Detailed information about location, numbers of customers affected and causes of power failure will increase efficiency in resolving network failure and generally simplify outage management. From quicker and more precise response, non-supplied customer minutes are assumed to be reduced by the introduction of an enhanced smart metering system. This benefit, however, should not be estimated meter by meter. A significant regional coverage will have to be in place before any effect materializes, established at 30%[101]. Further, the benefit derives from the low voltage distribution grid, as other parts of the voltage system already is equipped with more advanced, remotely controlled monitoring systems. Both households and SME are low voltage

[100] In the Lithuanian CBA theft, CML and network losses are grouped together in the category "commercial losses"

[101] In the UK CBA (2013) the benefit is realized gradually from 30% installation, in the Victorian CBA the benefit is realized in full only from 80% installation.

customers so all 2.54 million meter-points are assumed to benefit equally. In Victoria (Deloitte, 2011), a 5% reduction of CML is assumed. In the UK national CBA (DECC, 2013), a 10% reduction is assumed[102]. We deploy 5% as a conservative estimate, producing a total nominal benefit of 332 million over the scope of the CBA.

9.1.2.4 Reduction in electricity theft

Deployment of an enhanced smart metering system significantly improves the possibility for electricity suppliers to detect electricity theft. There is, however, no consensus on the extent to which electricity theft can be reduced. Italy is an interesting case with nationwide empirical data for more than ten years. The success rate of theft detection has increased by 70% as a result of smart meter deployment (Ilario Tito & Laura Panella, 2012). From the benchmark it ranges from a low 10% in the UK CBA (2013) to a high 70% in the Hungarian CBA (Atkearney and Force Motrice, 2010). The average of our benchmarks is a 40% reduction. In a separate benchmark report by European Regulators Group for Electricity and Gas (ERGEG, 2009), a range of 20-33% theft reduction is given[103]. Hence we adjust our own benchmarks average downwards to an expected 30% reduction in electricity theft. Reducing electricity theft by 30% has a total nominal value of 348 million NIS over the scope of the CBA. This gives an annual per-meter value of 9 NIS, somewhat higher than what was identified from our benchmarks[104].

9.1.3 Better billing – reduced bad debt and call center costs

This group of operational benefits arises from better and more detailed billing. We treat (9.1.3.1) debt management and (9.1.3.2) reduced call-center costs.

9.1.3.1 Debt management

From a large sample of literature, smart meters are expected to help avoiding debt for the consumers (CBA UK 2012, Capgemini, 2008 and CER,2011a). Consequently also the electricity supplier benefits due to reduced costs in debt management and recovery. The

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102 In an umbrella term "Commercial Losses", where both theft, CML and grid losses are included, the Lithuanian CBA (E&Y) estimate a reduction of 50% for this category.

103 Quoted from Atkearney and Force Motrice (2010)

104 We have two benchmarks, UK and Ireland with per annum meter-values of 0.34 and 1 euro accordingly.

extent of the benefit depends on BaU-characteristics, particularly the detail-level and frequency of billing. We assume a bad debt reduction of 20% for Israel with the introduction of enhanced smart metering. We assume that the benefit materializes from the point of 40% deployment. In nominal value, this reduction in bad debt produces a total benefit of 77 million NIS over the course of the CBA. It translates to a value of 2 NIS per meter per year, and is consequently placed in the lower rage of our benchmarks[105]. Another benefit of that relates to debt management is the reduction in days of outstanding customer bills. The Enhanced metering system reduces the gap between meter reading and billing and thus improves the cash flow of the supplier. In brief, less outstanding debt will reduce financing fees (e.g. interest expenses. We have not quantified this benefit due to uncertainty of the estimate.

9.1.3.2 Reduction in call center costs

It is assumed that call center costs will be reduced by the deployment of an enhanced smart metering system. Two reasons are stated in the literature. Firstly, there will be less invoice related questions resulting from the end of estimated billing and the elimination of reading errors. Secondly, there will be more precise answers in the case of outages due to better and more detailed information. Automated responses are facilitated. The benchmarks, in estimated percentage reduction in call center costs, ranges from a low 20% in the UK CBA (2013) to a high 90% in the Lithuanian CBA (2012). The average value is 50%. From the KEMA (2012) pilot benchmark report, the average reduction in call center costs is 56%. Thus, 50% reduction is deployed for this CBA. The full realization of this benefit depends on a certain regional coverage (e.g. precise outage detection). Hence the benefit is modeled to materialize from 20% deployment. In nominal value, this reduction in call center costs produces a total benefit of 307 million NIS over the 15 years time scope of the CBA, or a per meter annual value of 8 NIS per. From our benchmarks, the average annual benefit per meter is 2 Euros, or 9.6 NIS.

9.1.4 Other operational benefits - Avoided analog meter deployment and maintenance

[52] From the benchmarks, Ireland (CER, 2011a) and the UK CBA (2013) values this benefit to 0,37 and 2,60 euros per meter per year respectively.

From the time enrollment of smart meter stars, no analog meter will be deployed. Hence, smart meters will be installed both where (a) analog meters are malfunctioning (2% of the meter park annually) and (b) where population growth enlarges the meter-park (1.6% annually). In the BaU scenario, these costs would have occurred at the cost of analog meter deployment. Additionally, smart meter deployment will eliminate maintenance costs for analog meters. To identify the true, incremental societal cost of enhanced smart metering deployment, these BaU costs are subtracted from the rollout scenarios. Hence, avoiding BaU-costs of analog meters due to (a) malfunctioning, (b) population growth and (c) maintenance is counted as a benefit in this section. The benefit is valued at the full procurement- and installation costs of analog meters, and amounts to 621 million NIS over the scope of the CBA.

Table 10: Operational Benefits

Remote reading benefits	Reduction in per cent
Avoided regular meter-reading costs	100.00%
Avoided special meter-reading costs	80.00%
Avoided disconnection/reconnection costs	100.00%
Information benefits	Reduction in per cent
Reduced network enforcement	2.50%
Reduced network losses	10.00%
Reduced customer minutes lost	5.00%
Reduced electricity theft	30.00%
Billing Benefits	Reduction in per cent
Reduced bad debt	20.00%
Reduced call center costs	50.00%
Other operational benefits	Reduction in per cent
Avoided analog-meter deployment, replacement and maintenance	100.00%

9.2 Demand response benefits

Demand response benefits are benefits that arise from consumer response to (1) tariff-systems, (2) feedback and (3) DLC. The actual benefit derives from (a) consumption reduction and (b) peak-shift. These benefits are less predictable as they have a strong contextual element and are linked to human behavior (e.g. peak-shift and electricity consumption reduction). To cover the gap between the total costs of enhanced smart metering and operational benefits, or to create positive net benefit, consumer involvement through demand response is necessary. When peak-demand is shifted, it is likely that overall consumption is reduced. In the same line of reasoning, when overall consumption is reduced, it is likely that the peak load is reduced accordingly. To avoid double-counting, however, we calculate each effect independently, assuming no such correlation internally between the variables[106]. Demand response benefits are given the following twofold structure: In (9.2.1) we identify the potential of demand response benefits, while we in (9.2.2) monetize the potential of demand response benefits.

9.2.1 Identifying the potential

With reference to inter-sectorial differences, households are found to be more responsive than SME for both consumption reduction and peak-shifting[107]. For this CBA, we assume the SME consumption reduction and peak shifting to be 50% of households. *With reference to peak shift potential*, the two crucial variables are (a) the load curve (depending largely on climatic variations) and (b) discretionary load (depending largely on central air conditioner saturation) (The Brattle group et. al. 2009 and CRA, 2005). Israel is positioned in the high end potential with regard to both. In identifying the potential for demand response we look at (9.2.1.1) Pilot reviews vs. National rollout; (9.2.1.2) Tariff systems; (9.2.1.3) Feedback effects and (9.2.1.4) DLC effects. To avoid double counting, we report only independent effects of each variable, controlled for the other variables[108]. Finally, when all the independent effects are counted, we summarize the total demand response effects on the household sector and the SME.

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[106] The findings of the Californian Pricing Pilot (CRA, 2005) supports that peak-shifting occurs without consumption reduction.

[107] See for example Ernst and Young (2012), CER (2011b) and Charles River Associates (2005). A UK study by Carbon Trust 2007 disputes this evidence.

[108] In the strict sense this requires multiple regressions. Where multiple regressions are not conducted we still refer what the authors classify as independent effects of the variables.

9.2.1.1 Pilot reviews vs. National rollout

We make use of two sources for estimating the effect of demand response, pilot reviews and CBAs of national rollouts[109]. The pilot reviews considered cover a total of 170 pilots in various parts of the world, based on diverse designs regarding size, time-span and methodology. For an overview of the relevant CBAs see table 1 in section (4.1). In table 11 below, the data gathered from the pilot reviews and the national CBAs is summarized. One should note two reasons for why the pilot-reviews show higher savings and peak-shifts than the CBA results. First, the majority of pilots are based on an opt-in design[110]. Second, pilot results tend to weaken when sample size and the time horizon increases[111].

Table 11: Comparison of Pilot Reviews and National CBAs

Comparison Pilots and National CBAs – Averaged numbers	Energy reduction % min- (Average)- max	Peak-Shift % Min – (Average) – Max
From Pilot Reviews	2.95 - (5,95) – 9.1	14,4 – 14,5
From National CBAs	1,5 - (2,6) – 3,6	2,5 – 10
*Average numbers from 5 large pilot reviews of 170 pilots together		

9.2.1.2 Tariff-systems – TOU, CPP and RTP

One of the principal features of smart metering is the ability to record individual customer energy usage in fifteen-minute intervals. Interval data enables retail and network prices to reflect the different costs of supplying electricity at different times of day. There is conclusive evidence drawn from a large database of pilot studies to that tariff-systems moving away from flat-pricing towards more dynamic pricing will lead to peak reduction and total consumption reduction[112]. In this section we look at (9.2.1.2.1) Time Of Use (TOU), (9.2.1.2.2) Critical Peak Pricing (CPP) and (9.2.1.2.3) Real Time Pricing (RTP). It is important to note, however, that the effects of each tariff crucially depend on adequate tariff policies.

[109] In total, the results are based on 40 reports and articles.
[110] See Klopfert et. al. (2011)
[111] Se ACEE 2010 and Vasaett (2011)
[69] See Vasaett (2011), ACEE (2010), Faruqui (2005, 2007, 2009 and 2011) and Klopfert et. al. 2011.

9.2.1.2.1 Time Of Use (TOU)

TOU, as defined in this CBA, is a tariff that divides the 24 hours of the day into three different price levels. The price varies between these price-blocks, but not within. The price variations are the same every day and are engineered to approximate the peak and non-peak hours. TOU is the default tariff accompanying every smart meter deployed. . We do, however, assume a dropout rate of 15% with 5% moving to RTP and 10% moving back to flat tariff. For the sake of simplicity, we assume this dropout to be immediate – i.e. it will appear in the model as if only 85% of the meters come with TOU. *First, we look at peak shift resulting from TOU.* In four recent, extensive pilot reviews based on 185 pilots, the average effect of TOU on peak shift is 5%[113]. The often cited California Pricing Pilot (CRA, 2005), reports a peak shift of 5.9%. The range in the available data is large, from 0-25%, depending crucially on peak to off peak price ratio deployed for the TOU rate (Faruqui and Sergici, 2013). *Second, we look at consumption reduction resulting from TOU.* Vasaett's (2011) review of 13 pilots finds an average consumption reduction of 5% from TOU. In the sophisticated CER (2011) trial from Ireland, TOU was found to reduce consumption with 2.7%. As elaborated in 9.2.1.1, the pilot results will be dramatically higher than what can be expected in a nation-wide deployment[114]. Consequently, for the 85% of customers covered by TOU, we assume an independent effect of 0.25% and 0.5% from consumption reduction and peak-shift respectively.

9.2.1.2.2 Critical peak pricing (CPP)

CPP is a tariff design where customers are charged a higher price during a few hours and a discounted during the remaining hours. For these critical peak hours, the price-ratio of peak to non-peak is larger than in the TOU-tariff. We assume CPP will be combined with TOU as a complementary tariff[115]. Given the unfamiliarity of Israeli customers to choose tariffs, we deploy a conservative opt-in rate of 20%. We model this as if 20% of the

[113] Vasaett (2011), ACEEE (2010), Newsham and Boker (2010), and Faruqui and Sergici (2013).
[114] As an example for TOU, three Australian CBA for Victoria by (1) Oakley Greenwood (2010), (2) Futura (2011) and (3) Deloitte (2011) uses 1% and 1.5% for consumption reduction and peak-shifts respectively. But because of their opt-in design, we have adjusted this downward to 0.25% and 0.5% respectively
[115] See Faruqui, Ahmad 2012.

meters are “installed” with CPP. Because CPP only is used during a few critical hours of the year, it is not assumed to impact overall consumption reduction. *Regarding peak shift*, data from the Vasaett study (2011) displays an effect of 16% from CPP[116]. The Californian Pricing Pilot (CRA, 2005) finds a peak shift of 13.1% - 15.8% for critical days[117]. In an extensive pilot review from the brattle group (Faruqui and Sergici, 2013), the range is from 10-50% depending on peak to off-peak price ratio. For CPP we assume an opt-in design, so the pilot results are credible indicators of what can be expected in a nation-wide rollout[118]. Consequently, we expect CPP customers to reduce the peak consumption of electricity by 15%. Since the evidence is inconclusive, we do not expect CPP to affect overall consumption.

9.2.1.2.3 Real time pricing (RTP)

Real time pricing exists when the consumer at all times pays the real market cost of delivering electricity. Thus, (1) the price is not known far in advance, (2) no two days have the same rate structure, and (3) there can be much greater extremes of on-peak to off-peak price compared to CPP. In the Vasaett (2011) study, across a sub-set of 22 pilots, RTP is found to reduce consumption by 13% and shift peak consumption by 12%. The extent to which these results can be replicated depends on the wholesale energy price and its variations. To be conservative, we model an opt-in rate of 5%, with an according consumption reduction and peak shift of 10%.

9.2.1.3 Feedback

Smart metering will open up for consumers to get more detailed and meaningful information about their consumption. The presentation of this information to the customer is called feedback. Several studies are dedicated to isolate the effect of various feedbacks[119]. The results are straight forward, the closer to real-time the feedback the larger the effects. The results, however, are also showing that sample-size and time horizon influence the effect of feedback –

[116] Based on a sub-set of 69 pilots.
[117] Customers in warm areas with central air condition are identified as the most responsive consumer group.
[118] Three CBAs for Victoria all operate with 15% peak-reduction from CPP (Oakley Greenwood 2010, Futura, 2011 and Deloitte, 2011)
[119] See particularly ACEE (2010), Vasaett (2011), CER (2011b) and Faruqui et. al. (2009)

larger samples and increased time-frame are both inversely correlated to customer responsiveness[120]. We operate with three type of feedback, each given an independent demand-response contribution. Specifically we look at (9.2.1.3.1) Enhanced Billing, in (9.2.1.3.2) Web-Portal and (9.2.1.3.3) In Home display. Feedback is not assumed to have any impact on peak-shift, only consumption reduction[121].

9.2.1.3.1 Enhanced billing

Enhanced billing provides more detailed information about energy consumption patterns attached to the regular electricity bill. It is a service that will be provided to every customer. In the Vasaett (2011) study, based on a sub-set of 27 pilots, enhanced billing reduces consumption by 5.9%. In another comprehensive pilot-review by ACEEE (2010), the comparable result for 34 pilots is 3.8%. In a recent, large scale customer trial from Germany, the combined effect of enhanced billing and web-portal information was found to reduce consumption reduction by 5%. The results were tried econometrically and found to be statistically significant. In the California Pricing Pilot (CRA, 2005), however, increased information without price signals did not significantly reduce consumption. For the current CBA, benchmarking to other CBAs, we estimate the independent effect from enhanced billing to be 0.5%[122].

9.2.1.3.2 Web-Portal

The enhanced smart metering system will also provide a web-portal where end users can login to receive real time consumption feedback. A well designed web-portal can serve as a substitute for an In Home Display. Depending on its exact functionalities, a web-portal is found to reduce consumption significantly across a range of studies. In the Vasaett (2011) study based on a sub-set of 7 pilots, a web-portal is found to reduce consumption by 5.13%. In another pilot review by ACEEE (2010), the comparable result for 34 pilots is 6.8%. As explained in section 9.2.1.1, the savings for a nation-wide deployment will be dramatically lower. Conservatively, we give web-portal the same weight as enhanced billing, 0.5%.

[120] See Van Dam S. S., Bakker C. A. and Van Hal J. D. M, (2010)
[121] This assumption is in line with the Victorian CBA (Deloitte, 2011)
[122] See Oakley Greenwood (2010).

9.2.1.3.3 In home Display

In Home Display provides real time consumption feedback to the consumer. The display is connected to the smart meter through the HAN. We assume that 20% of the consumers opt-in for an IHD, and we model this as if 20% of the smart meters are deployed with an IHD. In short, (a) 100% of the consumers will receive enhanced billing and web-portal feedback, and (b) 20% of the consumers will receive enhanced billing, web-portal feedback and IHD. In the Vasaett study (2011), based on a sub-set of 30 pilots, IHD is found to reduce consumption by 8.68%. In the ACEEE study (2010), based on 34 pilots, the comparable reduction is 9.2%. Both of these studies, however, report declining effect when sample size and time horizon is enlarged. Another ACEEE (2012) study, looking at nine recent, large-sample pilots, found the effect of real time feedback (IHD) to range from 0-25% with an average of 3.8%. This is confirmed by BEUC (2011). Also the CER trial (2011b) in Ireland, one of the most trusted and cited customer trials conducted, displays a modest effect of 2.1% from IHD. A widely cited study from Netherlands (Dam, Bakker and Hal, 2010), despite initial positive figures, finds no statistically significant effect of IHD on consumption after four month. These considerations have led us to adopt a conservative saving rate of 3% for IHD[123].

9.2.1.4 Automation - DLC[124]

There are limits to the speed with which customers can manually react to price signals even with appropriate feedback. Thus, automated responses strengthen the effect of demand response. Through the Home Area Network (HAN), smart meters can automate home appliances. In this CBA, appliances equal Air Condition[125]. Consumption reduction through DLC is achieved through either (a) higher thermostat set-points or (b) limited cycling. Since automation here depends on price signals, customers with a DLC device are a subset of those enrolled in TOU, CPP or RTP. We assume that 20% of the population will opt-in to some sort of automation, and for the sake of modeling we expect identical response from these consumers. This is a low opt-in number compared to findings of

[123] Three CBAs for Victoria all operate with 6% energy saving from IHD (Oakley Greenwood 2010, Futura, 2011 and Deloitte, 2011). We have adjusted the number down to 3% based on recent studies reported.

[124] In this CBA we make use of a general category for automation, and we use DLC and automation as interchangeable concepts. I.e. we do not distinguish between the different types of automation (e.g. DLC, cycling).

[125] In a recent, sophisticated statistical analysis performed by The Brattle Group (2009) of demand response potential in the US, peak reduction potential is uniquely tied to centralized Air Condition saturation.

The Brattle Group et.al. (2009) in the US, but it matches the number given for the Victorian CBA by Deloitte (2011). In the Vasaett (2011) study, based on a sub-set of 85 pilots, DLC is found to have an incremental effect on peak-shifts of 16%. Their findings are confirmed by a large range of studies and particularly robust for consumers living in warmer climates with central air conditioning[126]. Consequently, we assume that customers subscribed to automation will reduce peak consumption by 15%[127].

9.2.1.5 Demand response variables in this CBA – an overview

We now, based on all the assumptions above, present an overview of the estimated energy-savings and peak-shifts for (a) the household sector and (b) the small-to-medium-enterprises (SME). The overviews are displayed in table 12 and table 13 respectively. As described in the methodology, to arrive at the expectations given for the SME, we simply multiply the Household results with a factor of 0.5 as we expect only half of the response. Note that the weighted total consumption reduction and peak-shift reduction for the household sector (2.31% and 6.93% respectively), should not be confused with total economic impact. Given that the households compose 32.4% of total consumption, the economy wide effect on consumption reduction and peak-shift is 0.94% and 2.24% respectively. The same logic applies for SME where the corresponding values for the nation-wide impact are 0.10% and 0.23% given that their share of total consumption is 6.7%.

[126] See for example: Newsham Guy R. and Bowker Brent G. (2010) and CRV (2005)

[127] From the three Victorian CBAs an average of 17.5% is deployed as the independent effect of DLC (Oakley Greenwood 2010, Futura, 2011 and Deloitte, 2011).

Table 12 : Demand response effects from the Household Sector

Demand-Response Variables*	Percent of population in each group	Independent Contribution to Consumption Reduction	Independent Contribution to Peak-shift	Weighted total consumption reduction for household sector	Weighted total peak-shift for household sector
Tariff-systems					
Time Of Use	85.00%	0.25%	0.50%	0.21%	0.43%
Critical Peak Pricing	20.00%	0.00%	15.00%	0.00%	3.00%
Real Time Pricing	5.00%	10.00%	10.00%	0.50%	0.50%
Stay of flat tariff	10.00%	0.00%	0.00%	0.00%	0.00%
Feedback					
Enhanced Billing	100.00%	0.50%	0.00%	0.50%	0.00%
Web-Page	100.00%	0.50%	0.00%	0.50%	0.00%
In Home Display	20.00%	3.00%	0.00%	0.60%	0.00%
Other					
Direct Load Control	20.00%	0.00%	15.00%	0.00%	3.00%
Total Household Consumption reduction and peak-shift				**2.31%**	**6.93%**

*Note that the percentages are not meant to summarize to 100% as several demand-control variables are coexisting (e.g. TOU and CPP; Enhanced billing, Web-Page and IHD)

Table 13: Demand response effects from the Small to Medium Enterprises (SME)

Demand-Response Variables*	Percent of population in each group	Independent Contribution to Consumption Reduction	Independent Contribution to Peak-shift	Weighted total consumption reduction for SME	Weighted total peak-shift for SME
Tariff-systems					
Time Of Use	85.00%	0.13%	0.25%	0.11%	0.21%
Critical Peak Pricing	20.00%	0.00%	7.50%	0.00%	1.50%
Real Time Pricing	5.00%	5.00%	5.00%	0.25%	0.25%
Stay of flat tariff	10.00%	0.00%	0.00%	0.00%	0.00%
Feedback		0.00%	0.00%		
Enhanced Billing	100.00%	0.25%	0.00%	0.25%	0.00%
Web-Page	100.00%	0.25%	0.00%	0.25%	0.00%
In Home Display	20.00%	1.50%	0.00%	0.30%	0.00%
Other		0.00%	0.00%		
Direct Load Control	20.00%	0.00%	7.50%	0.00%	1.50%
Total SME consumption reduction and peak-shift				**1.16%**	**3.46%**

*Note that the percentages are not meant to summarize to 100% as several demand-control variables are coexisting (e.g. TOU and CPP; Enhanced billing, Web-Page and IHD)

9.2.2 Monetizing the potential

In monetizing the potential of demand response effects, we separate between (a) the effect of peak-shifts and (b) the effect of consumption reduction. The effect of peak-shifts is divided into (9.2.2.1) Short term value of peak-shift and (9.2.2.2) Long term value of peak-shifts, while the effect of consumption reduction is divided into (9.2.2.3) Consumption reduction and (9.2.2.4) Co2-value of consumption reduction.

9.2.2.1 Short term value of peak-shifts

When load is shifted from peak to off-peak periods, a short run marginal cost saving will be realized as a given amount of energy can be generated at a lower average generation cost, minimizing production-related costs within the wholesale market by balancing generation and demand in a more cost effective way. Note than since peak-shifts are not assumed to contribute to overall consumption reduction, the lower peak consumption is assumed to be counter-balanced by higher off-peak consumption. With this constrain, the short run value of peak-shifts is the difference in generation costs between peak and off-peak periods. In other words the society saves the incremental marginal cost (above average generation costs) of generating peak electricity. To capture the full value of this benefit, every Kwh during the year shifted from higher- to lower marginal generation cost should be valued, even at small cost differences. This, however, is not in the scope of the current CBA, so we account only for the most critical hours, estimated to be 100 peak-hours per year[128]. We value each Kwh shifted from peak-hours to non-peak hours at 0.314 NIS. This is based on current generation cost differences of production provided by IEC adjusted to facilitate future use of natural gas[129]. In nominal values, the short term value of peak shift is 160 million NIS over the scope of the CBA.

9.2.2.2 Long term value of peak-shifts

There is broad literature on how peak-demand is concentrated around 1% of the time, about 80-100 hours a year. It is uniquely for this 1% we build new power stations. For Israel, peak-hour in summer is 2-3 o'clock. At winter-time, the peak is in the evening around 6-9 o'clock. Both peaks results to a large extent from use of air condition for cooling and heating respectively. Winter and summer peaks have come closer and closer (IEC statistical report, 2012). The long term value of reducing this peak can be divided into (a) deferred generation capacity and (b) deferred grid enforcements.

[128] 100 hours are reported by the IEC as the most critical peak hours of the year. This is supported by broad literature, see for example Faruqui et. al. (2007).

[129] Specifically we reduced the current peak price of generation given by IEC downwards by 40% before we calculated the difference.

Firstly, we look at the value of deferring generation capacity. We have the BaU-scenario growth in production over the time scope of the CBA from the Israeli Ministry of National Industries (MNI, 2013). Reduction in peak-demand will defer building of planned power plants. As outlined in section (8.1.1), we value deference of power-plants in line with the Israeli Ministry of National Industries (MNI, 2010). Their calculation, based exclusively on the cost of an average power-plant in Israel, is that each KW capacity not built has a value/cost of 1250 US$, or 4563 NIS[130] . Since an average power-plant has a capacity of 360 MW, the total value of deferring a power-plant is 1.643 billion (MNI, 2010). Increasing generation capacity is done stepwise. Consequently, also deferring generation capacity is valued stepwise, not marginally. Capturing the stepwise value and taking into account a time-lag representing the planning horizon of such an investment, we value the deference of a power-plant gradually from the moment 60% of the 360MW is deferred[131].

Secondly, we look at the value of deferring grid enforcements. Increased generation capacity requires grid enforcements. Consequently, for every KW generation capacity deferred, there will be a corresponding reduction in network-enforcement costs. Grid enforcements, however, particularly in the distribution grid, are lumpy, and there is no international consensus of how to measure this effect. In a recent, detailed cost assessment done by Oakley Greenwood for Victoria (2010), for every dollar saved in deferring generation, 54 cents was assumed to be saved in deferring network-enforcement. Their estimate is referred to as conservative[132]. Looking at the Israeli ratios of "total network investments" to "total generation investments", these have averaged at exactly 0.54:1[133]. From Israeli expert assessments, however, a much lower ratio has been suggested for this CBA. We agree with the conclusion of Brattle group (2007) that the value is unlikely to be zero, but even their own estimate of a 0.1:1 ratio is found unreasonably high. Consequently, we adopt a 0.05:1 ratio for this CBA. As one KW generation capacity deferred is valued at 1250 US$, the corresponding value for deferred network-

[130] From the report it is quoted: "Assuming it is a 'combined cycle power plant', with an installed capacity of 360 Megawatts, 4,500 hours of activity per year, and an efficiency rate of 85%, which allows the supply of 1.386 billion Kwh. In the present paper, a conservative production assumption of 1.1 billion Kwh was applied to the plant (20% lower)."

[131] The value of not building an additional power-plant starts when 60% its total capacity is deferred, and is spread over 3 years in the following manner: 20% first year, 40% in second and third year. The logic is that the project horizon of an average power-plant is 3 years.

[132] The CBA by Oakley Greenwood for Victoria (2010) notes that $110.000 MW/yr for deferral of network augmentation was deployed in a recent CBA, with 130.000 MW/yr for generation deferral. For their own CBA they deploy a common value of 200.000 MW/yr.

[133] Calculated from 2010–2017, where 5.937 bn was found to be total generation investments and 3.097 was found to be total network investments. The average relation between the two over the 8 years was 54%.

enforcement is 62 US$, or 228 NIS. Adding the per-KW-value of avoided network generation, the total long term benefit of avoiding one power-plant is 1.725 billion NIS. Over the time scope of the CBA, resulting from the peak-shifts elaborated in table 12 and table 13, one power-plant is deferred at a nominal value of 1.725 billion NIS.

9.2.2.3 Consumption reduction

Consumption reduction has a direct value to the end consumer by lowering electricity expenditures. From a national point of view, ceteris paribus, lower electricity consumption equals reduced total costs of generating and supplying electricity. To value consumption reduction, only the long run variable component of the tariff should be included – i.e. components of the tariff not varying with consumption should be excluded[134]. Fixed cost elements are excluded. From IEC data, this value is determined to be 0.33 NIS per Kwh in average. In total, given the consumption reduction estimated from table 12 and table 13, the nominal value of consumption reduction is 2.619 billion NIS over the scope of the CBA.

9.2.2.4 Co2-value of consumption reduction

Reduced electricity consumption also reduces Co2-emission. Reduced CO2-emission is valued by the national economic council to 0,078NIS per Kwh[135]. In total, given the consumption reduction estimated from table 12 and 13, the nominal value of Co2 reduction is 619 million NIS over the scope of the CBA.

10. Results

In the result part of the CBA, we combine the partial costs and benefits discussed in detail over the previous sections into total costs and benefits. We aim at analyzing how the total costs and benefits of enhanced smart metering develop over time and in relation to each other. We proceed in a fourfold structure: (10.1.1) Total costs figures, (10.1.2) Total benefit figures, (10.1.3) Main results and (10.1.4) Sensitivity analysis. For ease of interpretation we present the

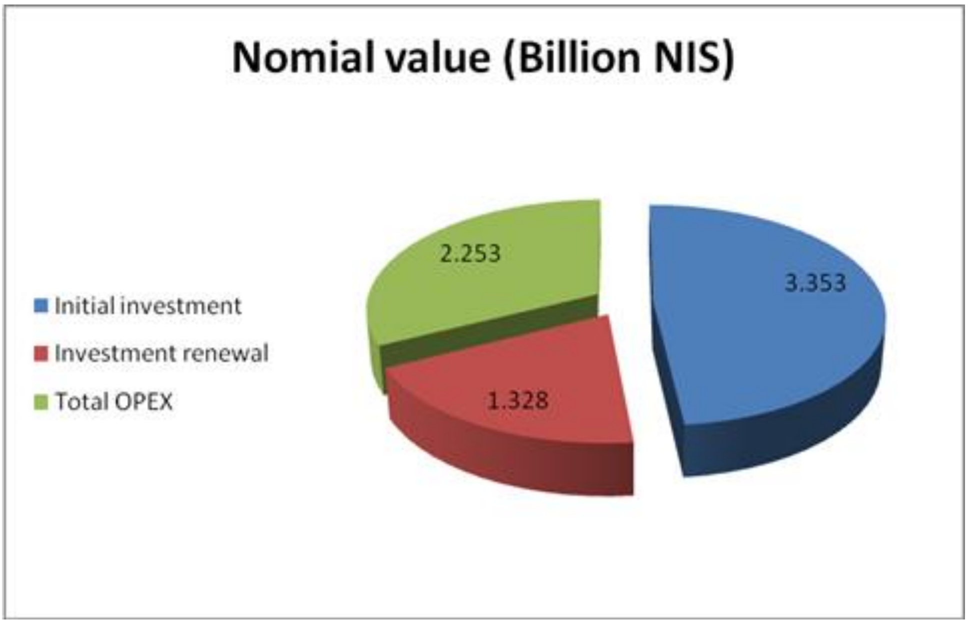
[134] See DECC (2013) for a thoroughly explanation.
[135] In the report Kwh "The committee for evaluation of the economic benefit of renewable energies" – translated from Hebrew.

majority of the results in nominal values. Since this report in an assessment over time, however, the final results are presented in net present value (NPV).

10.1 Total Cost figures

The total costs of an enhanced smart metering deployment are 6.934 Billion NIS in nominal value. Figure 7 displays a high level of these costs, divided into CAPEX and OPEX. Total CAPEX of enhanced smart metering is 4.681 billion, while total OPEX of enhanced smart metering is 2.253 billion NIS. CAPEX is more significant than OPEX since it includes both (a) the initial investment (3.353 billion) and (b) renewal investments (1.328 billion). In this section we explore in detail (10.1.1.1) Total CAPEX, (10.1.1.2) Total OPEX and (10.1.1.3) Yearly cost operations

Figure 7: High level overview of CAPEX and OPEX in nominal values



10.1.1 Total CAPEX

The total CAPEX in the model horizon is 4.681 billion in nominal value. *From a macro level*, a distinction is deployed between "the initial CAPEX" and "CAPEX renewal". Brief, the former is initial required investment whilst the latter is refresh costs in the end of a technologies' lifecycle.

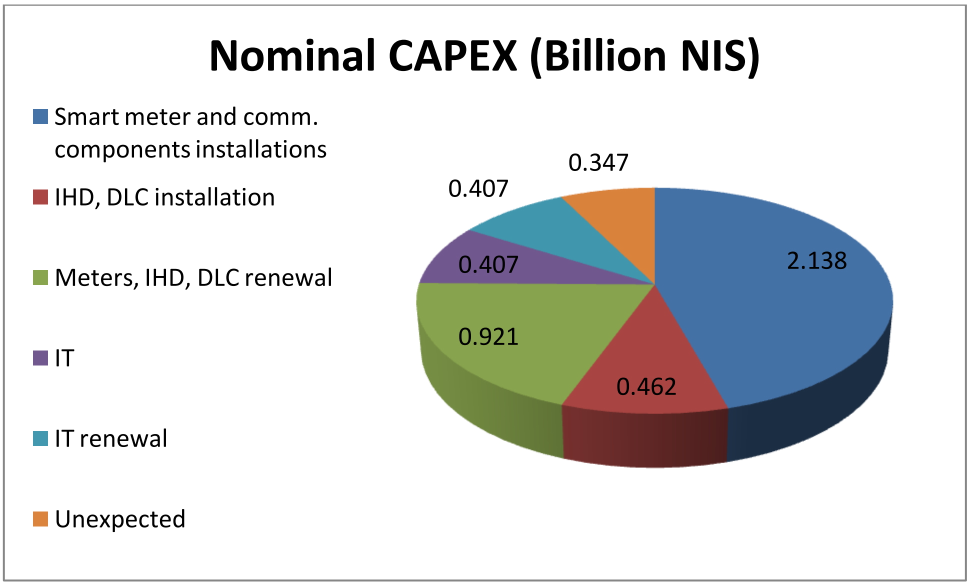
The distinction is important because (a) the reinvestment can be postponed, and (b) in the scope of the CBA we do not reap the full benefits of this CAPEX renewal[136].

- 3.353 billion NIS is the initial CAPEX investment.

- 1.328 billion NIS is re-investment in smart meters, IHD, DLC and IT.

From a micro level, total CAPEX is divided into (1) Smart meters and communication components installations (smart meter, concentrator , balancing meter), (2) IHD and DLC installations, (3) Meters, IHD and DLC renewal (4) IT (MDM and Web-page), (5) IT renewal and (6) Unexpected CAPEX. The division of CAPEX in nominal values is displayed in figure 8 The meters and communication equipment is the most significant capital expenditure (46%), while it's renewal is the second largest investment (20%). As shown in the figure, we literally invest twice in MDM and web portal (IT), given the fact that we re-invest in both at a rate of 10% annually (two years after the initial investment is completed).

Figure 8: The division of CAPEX in nominal values throughout the model (15 years):

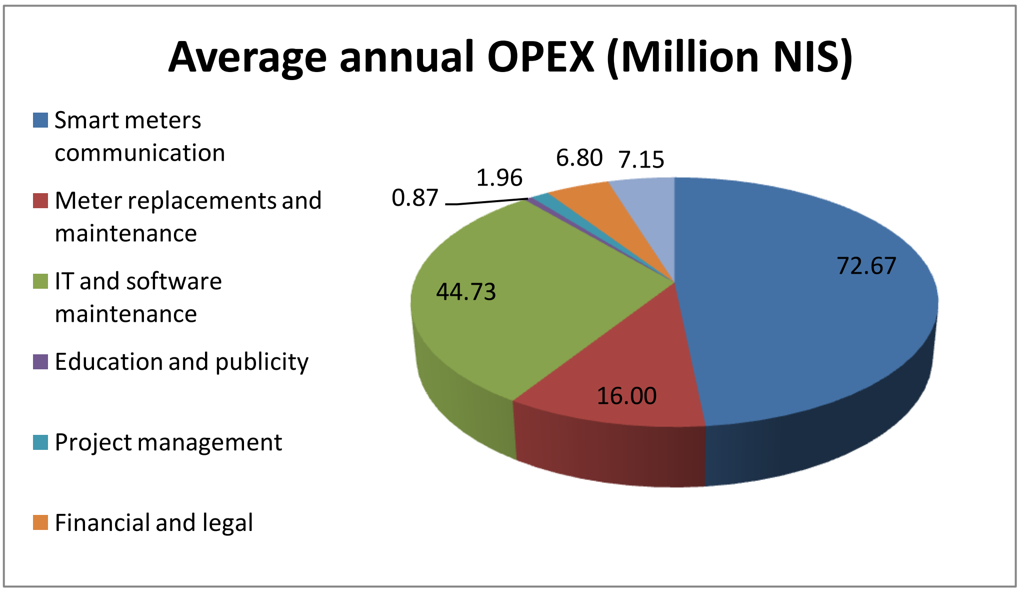


10.1.2 Total OPEX

[136] Since meter-lifetime from the literature is 15 years and we assume it is 10, there is an opportunity for decision-makers to postpone the reinvestment with consequently positive impact on the NPV. We include the reinvestment for conservative reasons, though its benefits from year 15 are not reaped in our model.

Total OPEX in the model horizon is 2.253 Billion NIS or an average of 150 million NIS annually in nominal value. Total OPEX is divided into (1) Smart meter communications (data transmission costs of smart meters, concentrators and HAN), (2) Meter replacement and maintenance (replacement and maintenance costs of smart meters, concentrators, balancing meters, IHD and DLC), (3) IT and software maintenance (e.g. annual management costs), (4) Education and publicity, (5) Project management, (6) Financial and legal and (7) Unexpected OPEX. The division of OPEX in nominal values is displayed in figure 9[137]. Data transmission is the most significant operational expenditure (48%), with IT and software maintenance as the second largest post (30%). Other expenses are relatively small.

Figure 9: Division of average annual OPEX in nominal values throughout the model (15 years):



<u>10.1.3 Yearly cost operations</u>

Figure 10 shows how capital expenditure and operational expenditure develop over the time scope of the CBA. The OPEX is forming a stable trend increasing with the number of meters deployed, averaging at 150 million NIS annually. CAPEX rises steeply over the initial IT-investment (3.5 first years), declines steeply at the end of the initial deployment (after 8.5 years), before it increases again with the 90% re-deployment rate from the 10th year.

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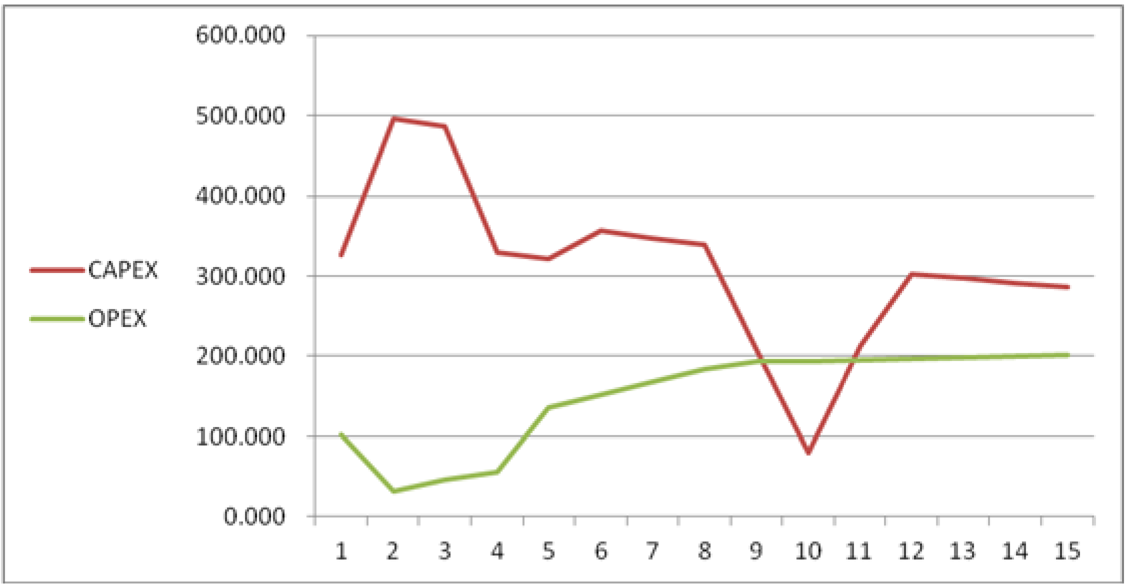
[137] Note that the values are annual and measured in million NIS.

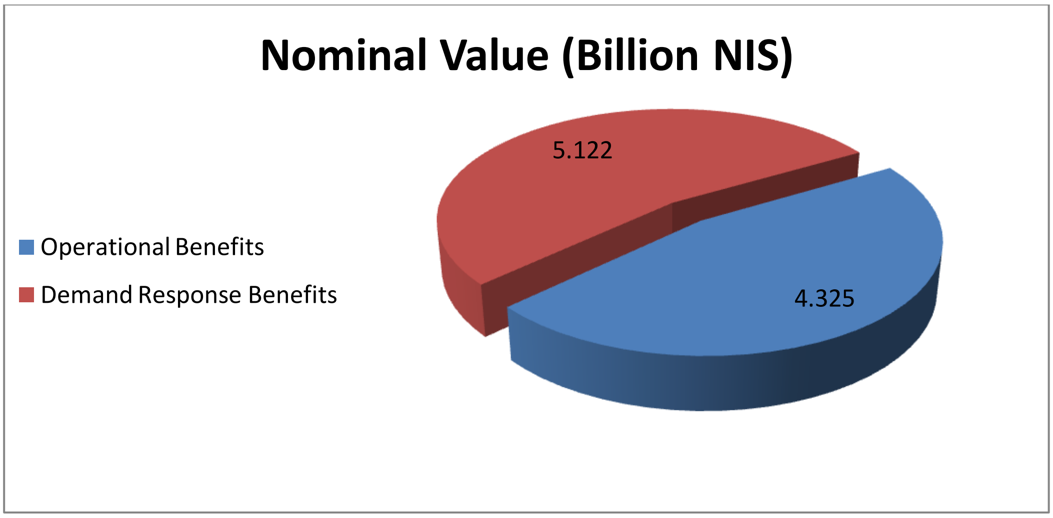
Figure 10: Development of total costs in million NIS over the time scope of the CBA (Nominal values). The costs are shown at the time of formation (i.e. not on a cash-flow basis):



10.2 Total benefit figures

The total benefits of enhanced smart metering are 9.447 billion NIS in Nominal value. Figure 11 displays a high level of these benefits divided into Operational Benefits and Demand Response Benefits. Total Operational Benefits of enhanced smart metering are 4.325 billion NIS, while Total Demand Response Benefits are 5.122 billion NIS. In this section we explore in detail (10.1.2.1) Total Operational benefits, (10.1.2.2) Total Demand Response Benefits and (10.1.2.3) Yearly benefit operations.

Figure 11: High level overview of Benefits in nominal values

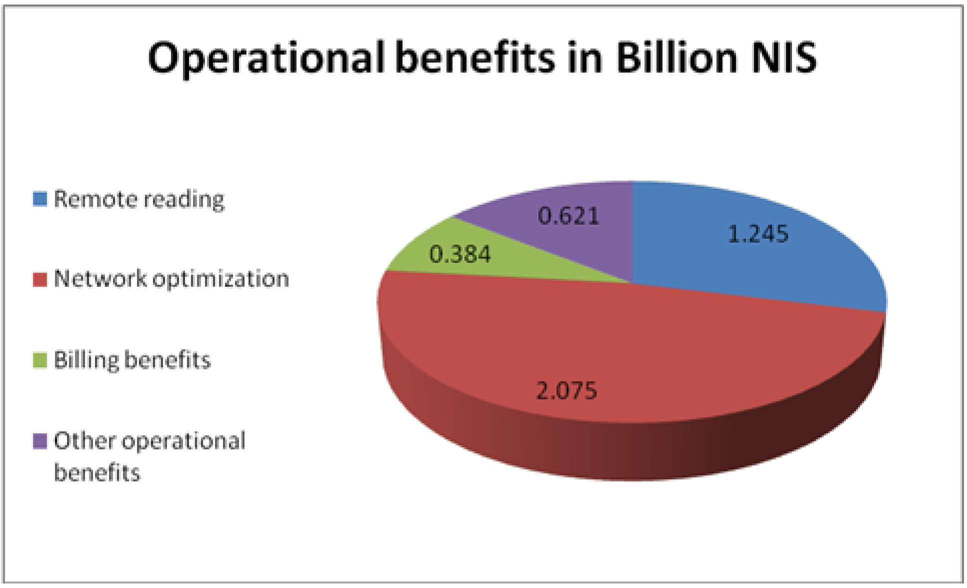


10.2.1 Operational benefits

Total operational benefits in the model horizon are 4.325 billion NIS in nominal value. Total operational benefits are divided into (1) Remote reading, (2) Information benefits, (3) Billing benefits and (4) Other operational benefits[138]. The division of operational benefits in nominal values is displayed in figure 12 Of the operational benefits considered, information benefits are the most significant sub-benefits (48%), mainly due to (a) reduction in network enforcement due to better planning and (b) reduction in network losses. Remote reading is the second largest post (29%), driven mainly by avoided regular- and special meter reading. Operational benefits alone cover 92% of the total capital expenditure (including re-investments in capital renewals, in nominal values). This is in line with what can be expected from the literature.

[138] For details on these categories see section 9.1

Figure 12: Division of total operational benefits in nominal values throughout the model (15 years):



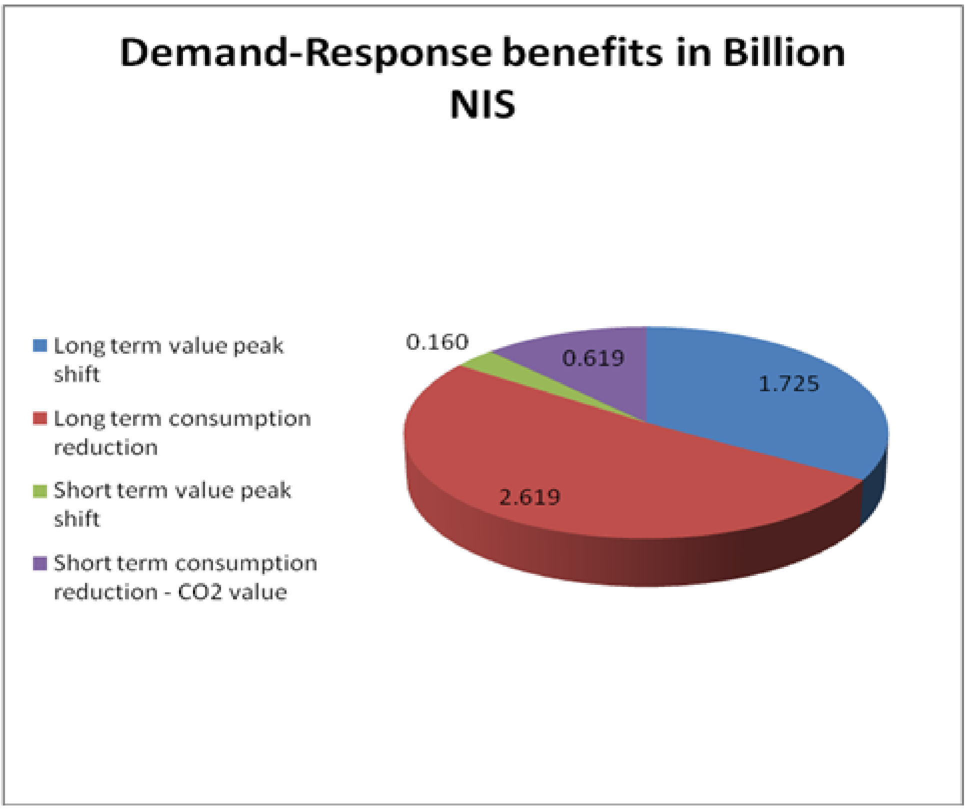
10.2.2. *Demand -response benefits*

Total demand-response benefits in the model horizon are 5.12 billion NIS in nominal value. . *From a macro level*, a distinction is deployed between short-term and long-term demand response benefits[139]. *From a micro level*, total demand-response benefits are divided into (1) Long term value of peak-shifts, (2) Long term value of consumption reduction, (3) Short term value of peak-shifts and (4) Short term value of consumption reduction[140]. Long term consumption reduction is the most significant of these, accounting for 51% of the total demand-response benefits. The second most important demand response benefit is the long term value of peak-shifts (34%), deriving from deferring one power-plant during the time scope of the CBA valued at 1.7 billion in nominal terms. Demand-Response benefits cover 109% of the total capital expenditure (including re-investments in capital renewals, in nominal values).

[139] We have, somewhat artificially, categorized Co2-reduction as a short term value of consumption reduction. It should be seen as a structural grip rather than a substantive categorization.

[140] For details on these categories see section 9.2

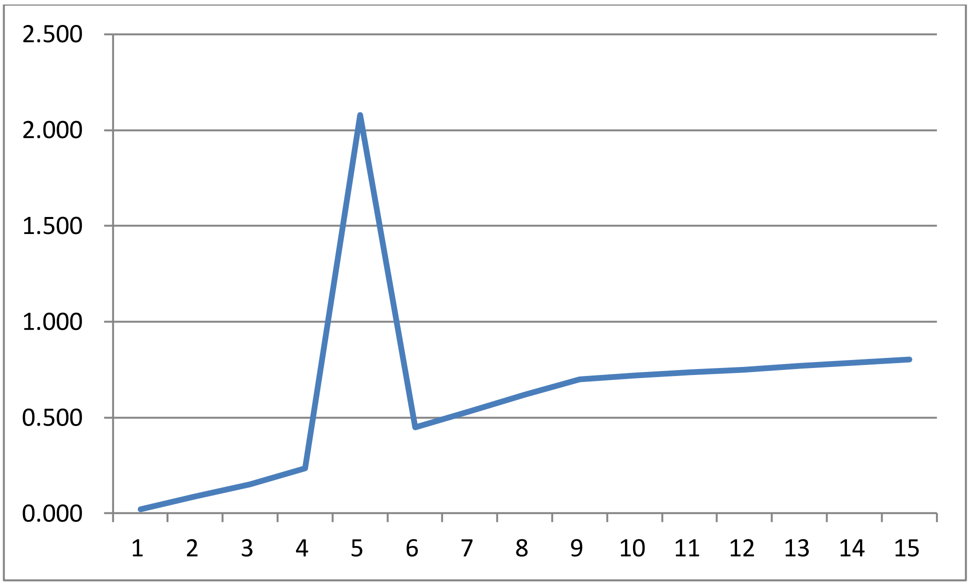
Figure 13: The division of total demand-response benefits in nominal values throughout the model (15 years):



<u>*10.2.3 Yearly operation of total benefits*</u>

Figure 14 shows how total benefits develop over the time scope of the CBA. There is a stable increase in benefits per smart meter deployed, with moderate reduction in the growth rate from the year of complete initial rollout (8.5 years). The dramatic demand response implication of deferring a power-plant can be seen in the fifth year.

Figure 14: Development of total benefits in million NIS over the time scope of the CBA (Nominal values). The benefits are shown at the time of formation (i.e. not on a cash-flow basis):

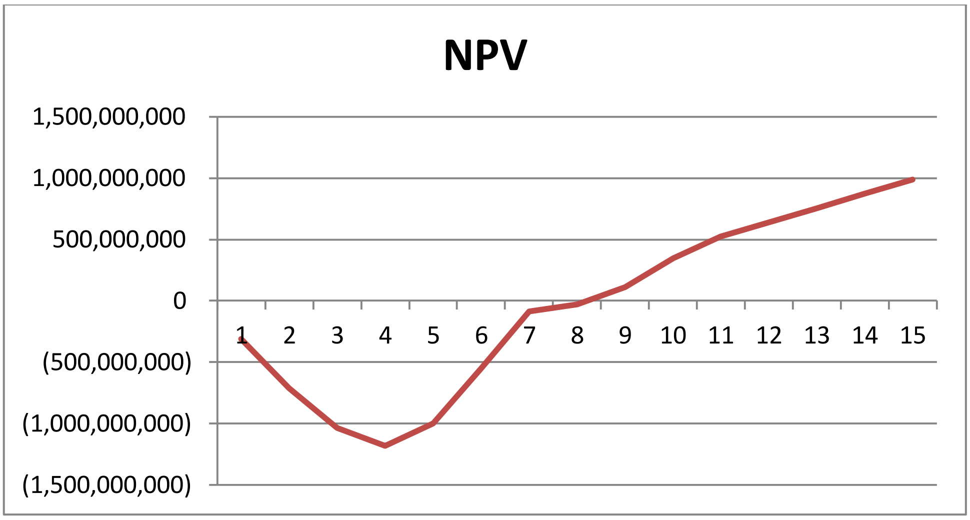


10.3 Main results – an NPV assessment of the investment

Over the 15 years time horizon of this CBA, enhanced smart metering deployment in Israel has a net benefit of 986.73 million NIS. Figure 15 displays how this NPV develops in time given the discount rate of seven percent. After the Initial IT CAPEX (407 million NIS) is completed after three and a half years, NPV shows a constant positive slope. In the fifth year there is a kink in the graph resulting from the deferring investments of a new power plant[141]. In the ninth year we get the first positive NPV.

[141] The benefit is spread over three years with a 20%, 40% and 40% distribution respectively.

Figure 15: NPV 2015-2030 given discount rate of 7%



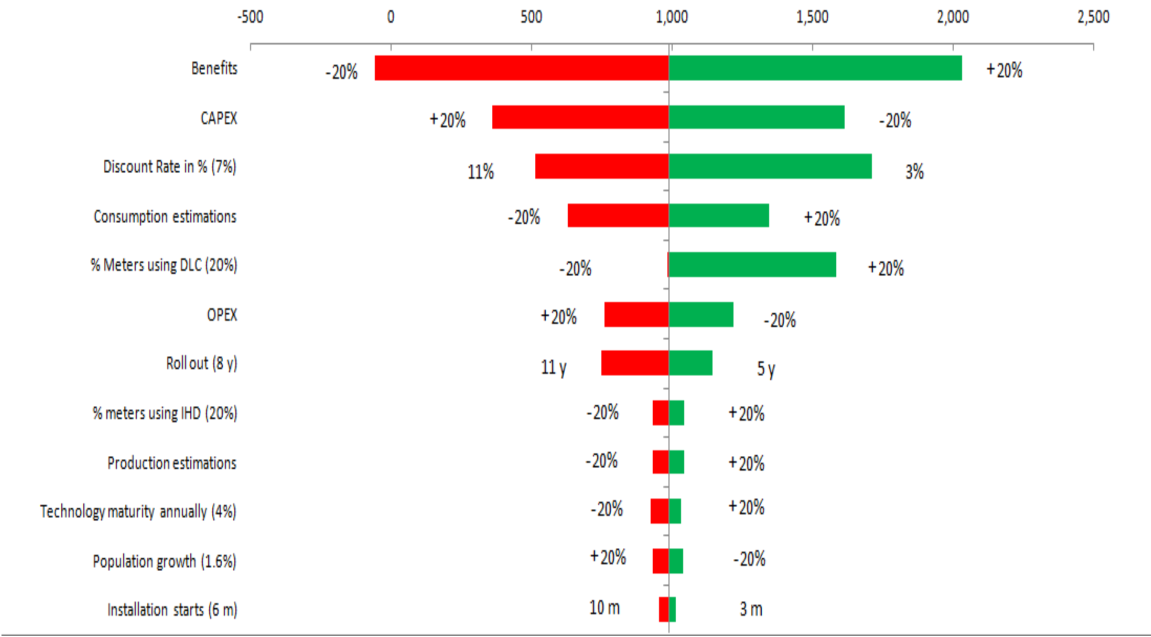
10.3.1 Sensitivity analysis

The sensitivity analysis is divided into (10.1.3.1) Standard sensitivity tests and (10.1.3.2) Cross-sensitivity tests. The main conclusion is that the positive NPV on enhanced smart metering is consistent and robust across a range of sensitivity tests.

10.3.1.1 Standard sensitivity tests

From figure 16 we see that the NPV is most sensitive to changes in (1) benefits, (2) CAPEX, (3) discount rate and (4) consumption estimations. The positive NPV remains robust across a range of sensitivity tests carried out. A reduction in benefits of 20% is the single parameter with a potential of turning the NPV marginally negative. In is worth noting that the NPV would still be highly positive (360 million NIS) should the CAPEX of enhanced smart metering be 20% higher than what we assumed. The same is true for the discount rate and our estimations for future consumption. The skewed result of DLC displays that a 20% increase in opt-in, due to its effect on peak-consumption, will defer an additional power-plant over the relevant time horizon.

Figure 16: Sensitivity Analysis, changes in NPV



10.3.1.2 Cross sensitivity tests

We use cross-sensitivity to identify the NPV-effect of simultaneous changes in our assumptions. We perform cross-sensitivity of the three most crucial variables - i.e. benefits, CAPEX and discount rate. *Firstly, figure 17* shows the sensitivity of total NPV to simultaneous changes in benefits and CAPEX. In one extreme scenario, 20% increase in CAPEX and 20% decrease in benefits would produce a negative NPV of 686 million NIS. In the first figure, this is the only combination of simultaneous changes that results in a negative NPV. *Secondly, figure 18* displays how NPV varies with simultaneous changes in benefits and discount rate. Again the extreme case, this time 20% lower benefits at a discount rate of 11%, displays a negative NPV (-269 million NIS). At a social discount rate of 3%, approximately the discount rate recommended for the European CBAs (JRC, 2011), even a 20% reduction in benefits gives a highly positive NPV of 276 million NIS. In total, we conclude that a highly positive business case for enhanced smart metering deployment in Israel is consistent and robust across a range of sensitivity tests.

Figure 18: Simultaneous changes in Benefits and CAPEX

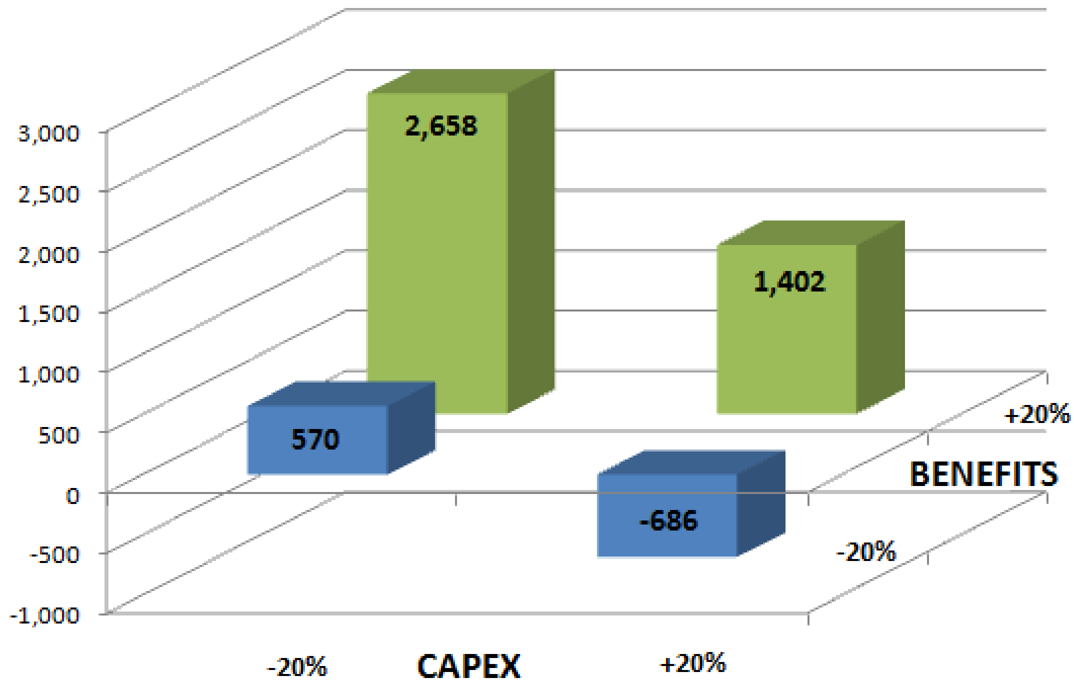


Figure ???: Simultaneous changes in Benefits and discount rate

11. Appendices

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CHAPTER 7

Smart Grid – The Israeli Industry Engagement

Amos Lasker

Executive summary

During the last 25 years the high tech industry positioned itself as the leading vehicle in Israel growing economy and export.

In the last few years several phenomenon are threatening the industry growth. The world continuous financial crisis, , The worldwide strong competition, the saturation of the traditional areas, structural changes, and the NIS revaluation. All these are leading to a reduction in yearly growth towards a one digit number.

The question is what are the emerging new business fields that can utilize existing and advance technologies of the Israeli high tech companies?

Today the Industry is mainly focusing on new solutions combining cloud, mobile, social, and Big Data elements. It is essential to identify new early stage businesses with significant potential growth utilizing the existing knowhow and experience.

A new field, relatively unknown to the Local Industrial community is the energy sector as a whole and the smart grid in particular.

The global focus on cleaner energy and energy efficiency has become a key driver for smart grid which is an integration of the Energy and Telecommunication systems. This turns SG to be a perfect solution for the evolution of the high tech industry.

The Israeli high – tech and electronic industry has more than 2000 companies who can provide services and products to the smart grid project, leveraging the country's strong base in semiconductors, power electronics, communications, IT,and human resources.

The potential investments in Israel in the next 10 years are estimated to be 5B NIS. In USA the figure until 2020 is $338B and in Europe Euro 56B. This represents a huge opportunity for the high tech Industry. The industry has to take action and to learn:

- The specific requirements of the energy system.
- The international standards ,
- The current available products ,
- The profiles of energy customers and their market needs
- The business advantage combined with risk analysis.

Based on the results each company can analyze the profitability of adapting its product line to the Energy sector.

Israel High tech and Electronic industry – background and figures

Israel high tech industry and its achievements are much known worldwide. It is considered as a success story and serves as an example to small nations lacking natural resources.

The achievements in technology are demonstrated in the following data:

Israel has the world's highest percentage of scientists, with 135 engineers per 10,000 citizens. In comparison, the United States has 85 per 10,000. This is mainly due to Immigration of thousands of skilled engineers and technicians from the former Soviet Union.

Israel is ranked *

- 1st in expenditure on R&D as percentage of GDP, and in quality of scientific research and institutes.
- 11/139 in company spending on R&D.
- 7/139 in capacity for innovation

- 10/139 in venture capital availability.
- 14/139 in University- Industry collaboration on R&D.

Israel is third in number of companies in the world listed on NASDAQ, this fits together with the fact that there are more startups in absolute terms than any other country outside the US.

Israel is exceptional as well in Innovative intellectual property results in registration of more scientific and technological patents per head.

In qualitative terms Israel is characterize by its Entrepreneur spirit and mentality of early adaptors. Israel enjoy a highly qualified scientists and engineers with proven track record and strong R&D,

Israel is unique in the proven success of commercialization of defense technology, as well as close cooperation of industries and academic researchers.

In terms of the international criteria:

- Significant numbers of high- tech star- ups companies being acquired by international firms or going public.
- Israel has very powerful VC community, which enjoy investment and R&D incentives.
- Many of the leading American investment houses and Venture Capital funds have established presence in Israel in order to support Israeli high-tech firms and benefit from the current boom

<u>The outcome is that During the last 25 years the high tech industry positioned itself as the leading vehicle in Israel growing economy and export.</u>

*Source: CBS, Global competitiveness index 2010-11.

The Problem

In the last few years the phenomenal success has been challenged, so that the yearly growth rate was constantly reduced to one digit number.

The reasons are a combination of macro – economic and structural changes.

- The world continuous financial crisis – The European debt crisis and the concern over US economic growth.
- The worldwide strong competition – The emerging power of Far- East economies
- The saturation of the traditional areas and the emergence of new technological platform such as mobile broadband, network cloud services, Bid Data, social networks, etc.
- The NIS revaluation due to the relatively strong Israeli economy.

The capital raised by Israeli VC funds was reduced from the 2000 pick of $2.8B to $0.8B in 2012. It is reflected in the percentage of VC funds investments out of total yearly investments in high tech companies. During the period 2003-2012 it was reduced from 42% to 24% *. On top of it some of the multinational companies reduced the budget allocation for local R&D centers.

This increases the reliance of the local industry on foreign investors and exposes it to the global financial crisis.

Another indication for technological innovation is the number of PCT applications which were reduced by 3-4% each year from 2008.

The problem is how Israel restores the high tech industry. What are the potential new business fields that can utilize existing and advance technologies of Israeli high tech and electronic companies?

- WIPO Statistics Database , March 2012.

The Solution

Typically all kind of these problems are addressed to the government. Even though much is dependent on government policy, the real solution is derived from the entrepreneur's initiatives. They should "reinvent" themselves by identifying new early stage businesses with significant potential growth utilizing the existing knowhow and experience .

Today the Industry is mainly focusing on new solutions combining cloud, mobile, social, and Big Data elements. A new field, relatively unknown to the local industrial community is the energy sector as a whole and the smart grid in particular.
The solid technical human resources enable the introduction of advanced technologies to new areas such as The Smart Grid.

It should be noted that the global focus on cleaner energy and energy efficiency has become a key driver for smart grid which is an integration of the Energy and Telecommunication systems. This is a perfect solution for the evolution of the high tech industry.

The following table presents the total potential of involvement of local companies classified by sector :

Sector	Total companies in the sector	Less relevant sub-sectors	Estimation of total relevant companies
Communications	701	VoIP, Broadcast	630
Internet	1111	Online entertainment, Search engines, e-learning	870
IT Enterprise	909	-	909
Semiconductors	123	Video/Audio, RFID	86
Total	**2844**		**2495**

- IVC Research Database

The Israeli high – tech and electronic industry has more than 2000 companies who can provide services and products to the smart grid project, leveraging the country's strong base in semiconductors, power electronics, communications, and IT.

The integration between business areas and Smart Grid.

The products and services for the Smart Grid include most of the high tech business areas:

- Data Management
- Data communication
- Data transmission
- Information technology.
- Big data analysis
- Databases for mainframe and mid- range computers.
- Core management applications
- Machine to machine communication
- Predictive intelligence
- Energy storage.
- Data security
- Encryption
- Antivirus Technologies.
- Internet technologies and products.
- Billing software.
- Wired and wireless products for core networks.
- Monitoring and diagnostics tools.
- Enterprise network
- Load sharing

- Energy efficiency. (Such as Building envelope isolation, Air condition cooling. Lighting, Solar water heating , Control systems).

The potential investments in Israel in the next 10 years are estimated to be 5B NIS. In USA the figure until 2020 is $338B and in Europe Euro 56B. This represents a huge opportunity to the high tech Industry. The industry has to take action and to learn:

- The specific requirements of the energy system.
- The international standards ,
- The current available products ,
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- The business advantage combined with risk analysis.

Based on the results each company can analyze the profitability of adapting its product line to the Energy sector.

APPENDIX

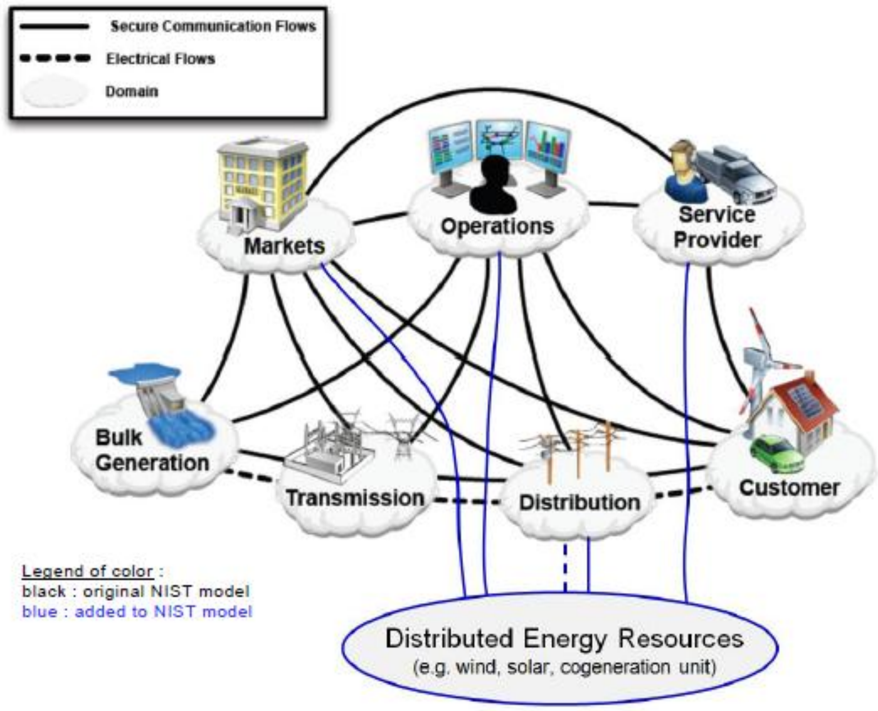
IEC role in the deployment and operation of the Smart Grid

General data

A smart grid is an upgraded electricity network to which two-way digital communication between supplier and consumer, intelligent metering and monitoring systems have been added[142].

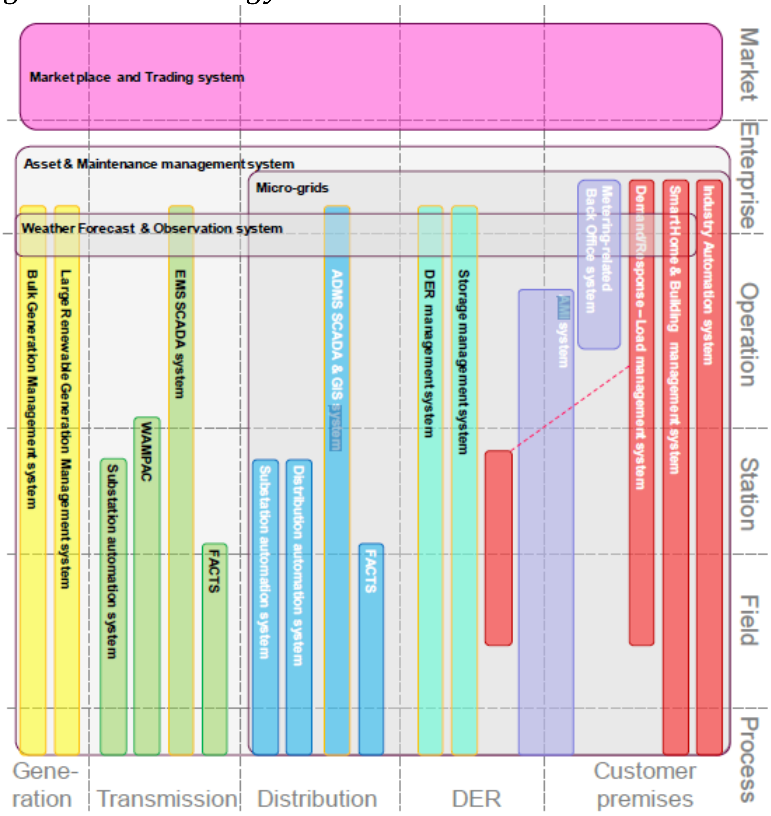
Smart metering is an inherent part of a smart grid. It consists of an electricity meter that records consumption of electric energy and communicates that information to the grid operator and energy supplier for monitoring and billing purposes. Thanks to this information consumers are able to directly control and manage their individual consumption. Moreover, the grid operator can better plan the use of infrastructure and balance the system, for instance in terms of integration of renewable[143].

Figure. 1: Smart Grid – conceptual model



[142] MEMO/11/ Brussels, 12 April 2011 Q&A on the deployment of smart electricity grids and smart meters
[143] Ibid

Figure 2: technology areas



The many smart grid technology areas – each consisting of sets of individual technologies – span the entire grid, from generation through transmission and distribution to various types of electricity consumers. Some of the technologies are actively being deployed and are considered mature in both their development and application, while others require further development and demonstration. A fully optimised electricity system will deploy all the technology areas in Figure 2. However, not all technology areas need to be installed to increase the "smartness" of the grid.

4. Wide-area monitoring and control

Real-time monitoring and display of power system components and performance, across interconnections and over large geographic areas, help system operators to understand and optimize power system components.

5. Information and communications technology integration

Underlying communications infrastructure, whether using private utility communication networks (radio networks, meter mesh networks) or public carriers and networks (Internet, cellular, cable or telephone), support data transmission for deferred and real-time operation, and during outages.

6. Renewable and distributed generation integration

Integration of renewable and distributed energy resources – encompassing large scale at the transmission level, medium scale at the distribution level and small scale on commercial or residential building – can present challenges for the dispatchability and controllability of these resources and for operation of the electricity system.

7. Transmission enhancement applications

There are a number of technologies and applications for the transmission system.

8. Distribution grid management

Distribution and substation sensing and automation can reduce outage and repair time, maintain voltage level and improve asset management.

9. Advanced metering infrastructure

Advanced metering infrastructure (AMI) involves the deployment of a number of technologies – in addition to advanced or smart meters that enable two-way flow of information, providing customers and utilities with data on electricity price and consumption, including the time and amount of electricity consumed. AMI will provide a wide range of functionalities:

- Remote consumer price signals, which can provide time-of-use pricing information.
- Ability to collect, store and report customer energy consumption data for any required time intervals or near real time.
- Improved energy diagnostics from more detailed load profiles.
- Ability to identify location and extent of outages remotely via a metering function that sends a signal when the meter goes out and when power is restored.
- Remote connection and disconnection.
- Losses and theft detection.
- Ability for a retail energy service provider to manage its revenues through more effective cash collection and debt management.

10. Electric vehicle charging infrastructure

Electric vehicle charging infrastructure handles billing, scheduling and other intelligent features for smart charging (grid-to-vehicle) during low energy demand.

11. Customer-side systems

Customer-side systems, which are used to help manage electricity consumption at the industrial, service and residential levels, include energy management systems, energy storage devices, smart appliances and distributed generation.

Business models

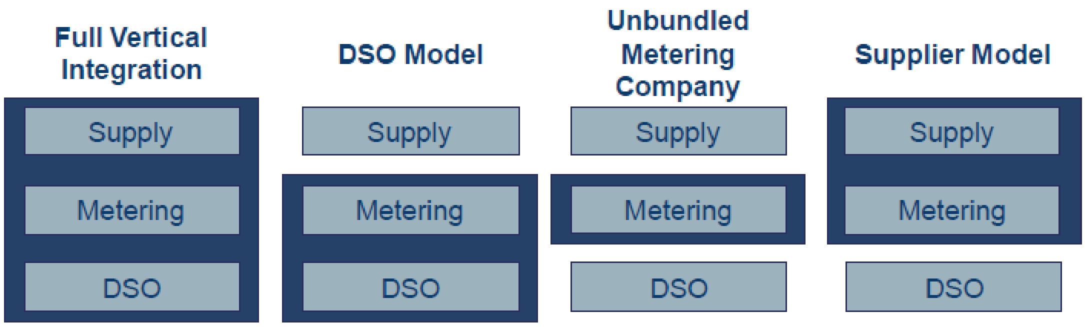
When deciding on a smart metering roll-out, the market model for the metering services has to be taken into account.

12. Basic Metering Market Models

Traditionally metering has been carried out as part of the distribution and supply activities of a vertically integrated utility. In such regimes the customer has (had) a single point of contact for network connection, supply, meter (installing, maintaining and reading) and invoicing (full vertical integration model).

Some other models could either be carried out by the distribution system operator as part of its regulated activities (DSO-model), by a separate metering company independent of the distribution and supply companies (unbundled metering company) or as an additional competitive service area of the supplier (supplier model).

Figure 3: Possible Options for the Structuring of the Metering Sector



Source: KEMA

In addition to this general structure of the metering market, the provision and operation of meters could be further broken down into several tasks that can be carried out by different market.

The traditional and still most common model of a monopolized metering sector, where the metering activities belong to the regulated activities of the DSO or to a separate dedicated regulated national/regional metering asset and service provider.

In almost all Energy Community Contracting Parties metering services remain part of the regulated DSO functions. The costs of meters are recovered via the regulated network charges, and investments in metering equipment are subject to regulatory approval.[144]

13. Fully integrated model or DSO Model

In this model, the Israel Electric Corporation Ltd. (IEC) takes up all roles concerning the smart meter, metering, communication and data base treatment. The IEC will take up the role of communication as he can use power line communication (PLC, if this technology is

[144] Regulatory Aspects of Smart Metering. Commissioned by: National Association of Regulatory Utility Commissioners (NARUC), Energy Regulators Regional Association (ERRA). Submitted by: D. Balmert, Dr. K. Petrov, KEMA International B.V, Bonn, 20 December 2010

used) to send the meter data. A roll-out of smart metering by the IEC could therefore be easily implemented into the existing industry structures. Moreover, as smart metering might be seen as the natural precursor of the smart grid, it makes great sense for the IEC to take up responsibility for smart metering.

Technical: As the meter comprises all functionality, installation of this system is relatively easy. It is required that the installation of the meter is taking place by a IEC's electrician. In terms of operational processes, the existing meter needs to be decoupled and replaced by a smart meter (including communication module), thus the meter data needs to be re-updated in the back office of the IEC, as well as some other administrative issues need to be changed and updated. When problems occur with the meter such as replacement of communication module for a new technology, the IEC's electrician will need to come down to each house, shutting down the full smart meter including electricity component, making the replacement and resetting the system.
This will require as mentioned below a lot of additional administration in the back office. In terms of communication, the IEC makes use of its own electricity network to connect the smart meters to its own telecommunication infrastructure via PLC or other communication channels. Additional investments are required in the access network installing amplifiers and connections points in order to cope with all the data (two-way) traffic taking into account a low delay and latency.

Business: As the IEC is taking care of all activities, everything can be arranged in a more organized and efficient way. They (IEC) also act as SPOC (single point of contact) for the end customer. When faults would occur in the network, either in the electricity, telecom and other component, the IEC is the only responsible party. This states that all required competences for all these components are available within the IEC organization.
The proposed model promotes the open and competitive market for suppliers and home automation. It is particularly in favour of emerging new service providers, e.g. aggregators. The service providers who are in conformity with the data security rules/certificates can participate with their products and services in the process and propose to the end users different energy efficiency and other value-added services.
Centralized implementation of the smart meter deployment makes able use of economies of scale in the procurement of components for smart metering systems (meters, gareways, communication modules and facilities). If the amount of orders doubles, the investment costs decrease by between 10 and 15% with increasing order quantities[145].

Customer: For the end customer a single solution with one SPOC would be best. Centralized database treated under stringent security standards will guarantee the consumers data safety and will safeguard their privacy.

[145] **"Kosten-Nutzen-Analyse für einen flächendeckenden Einsatz intelligenter Zähler",** Im Auftrag des Bundesministeriums für Wirtschaft und Technologie. Ernst & Young, August 2013

Deployment sequence

The industry has now learned smart meter system deployments are not the routine "technology upgrade" that utilities have performed for the past 100 years. The phrase known to every utility field technician, "we have the legal right to repair, replace, and maintain OUR equipment," while true, does not establish a foundation for a new type of customer relationship[146].

"Stealth" smart meter deployments would be very risky in today's environment[147]. IEC's adopted approach is a "neutral-to-positive customer experience" that would set the foundation to achieve future demand response goals. The goal depends upon a successful smart meter deployment..

As experience gathered so far shows, the deployment of smart metering will face many barriers. Despite the benefits of smart metering, market parties will not in all cases adopt smart metering voluntarily or willingly. Developments which may endanger successful smart metering deployment will be taken seriously throughout the process[148].

14. Consumer Resistance

Consumer resistance may present a serious barrier to smart metering deployment. Consumer resistance is probably the most difficult barrier to mitigate.

In most cases consumer resistance can be observed to be driven primarily by three reasons:

- Consumers might fear that security and privacy of data gathered by smart metering cannot be guaranteed and hence unauthorized parties might have access to private data; they may also be against the authorized usage of the data.
- Consumers might also fear that they would have to bear the costs for deploying a smart metering infrastructure or that new (time-of-use) tariffs would lead to higher energy costs, whereas consumers' benefits might prove to be overestimated.
- Consumers might fear of unknown: radiation, allegedly accompanying new communication devices (no real base under this conclusion) etc.

The case of consumers opposing smart metering deployment due to the amount and level of detail of personal data gathered is highly relevant. As concerns regarding data security and consumer privacy can be easily understood, given the nature and amount of data gathered, they should be taken seriously. Moreover, the timely acknowledgement of concerns may be crucial in preventing issues endangering the success of smart metering deployment and in creating the necessary public acceptance.

Personal data should in general be protected by privacy law. Special attention will be given to smart metering as the amount of personal data collected is much greater than ever before. Privacy standards and access rights should be in place before a smart metering roll-out is started. For example, The European Commission prepared[149] a recommendation for the roll-out of smart metering, which draws special attention also to the data protection issues.

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[146] THE SMART METER DEPLOYMENT HANDBOOK. NV Energy and U.S. Department of Energy, 2013
[147] Ibid

[148] Development of Best Practice Recommendations for Smart Meters Rollout in the Energy Community. By order of: Energy Community Secretariat. Submitted by: KEMA International B.V. Authors: D. Balmert, D. Grote, K. Petrov. Bonn, 2012
[149] COMMISSION RECOMMENDATION on preparations for the roll-out of smart metering system. 9 March 2012 , EU/2012/148

The second major concern consumers may have is the fear that smart metering may lead to higher energy costs. It is the regulator's task to ensure that only the justified efficient costs are passed through to consumers and that these costs are shared with other parties gaining from smart metering deployment.

If consumer benefits resulting from smart metering deployment are higher than the associated costs, then passing efficient costs through to consumers is justified. To prevent consumer resistance and to mitigate consumer concerns requires an effort to increase consumer awareness of energy savings potentials and to strengthen their confidence in the proposed reforms in metering infrastructure.

Strengthening consumer awareness, trust and knowledge is essential to mitigate consumer resistance. Smart metering deployment should be accompanied by an information campaign[150].

15. Legal/Regulatory Barriers

Successful smart metering deployment is thus dependent on regulatory authorities (PUA), governmental and legislative bodies. These institutions have to play a significant part in assessing costs and benefits of smart metering deployment, setting up the roll-out scheme and monitoring the actual implementation.

16. Revenue / Tariff Setting and Incorporation of Costs of Smart Metering

The lack of a consistent legal and regulatory framework sufficiently adjusted to foster a smart metering roll-out and to promote energy savings will pose a major barrier to successful smart metering deployment. The legal and regulatory framework should show commitment to the smart metering roll-out by governmental and regulatory authorities. Moreover it should explain clearly how the investment and operating costs will be accommodated in tariff regulation.

17. Deployment Strategies[151]

Besides the metering market model, one of the key questions when devising the smart metering deployment strategy is the decision on the speed of smart metering roll-out. The timeframe for a smart metering roll-out – if full-scale national roll-out is the objective – seriously affects costs and benefits, due for instance to the

- necessity to operate two systems in parallel as long as old meters are in existence,
- peaking demand for a qualified labor force,
- metering and communications hardware and installation equipment and
- stranded investments if old meters are replaced before reaching the end of their economic lifetime.

18. The Team

The overall accountability for smart metering projects will be assigned to a Smart Meter Steering Committee that is chaired by a senior vice president of IEC. The Steering committee will coordinate the various project workflows and functional areas. The Steering committee

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[150] Development of Best Practice Recommendations for Smart Meters Rollout in the Energy Community. By order of: Energy Community Secretariat. Submitted by: KEMA International B.V. Authors: D. Balmert, D. Grote, K. Petrov. Bonn, 2012

[151] Regulatory Aspects of Smart Metering. Commissioned by: National Association of Regulatory Utility Commissioners (NARUC), Energy Regulators Regional Association (ERRA). Submitted by: D. Balmert, Dr. K. Petrov. KEMA International B.V, Bonn, 2010

delegates responsibility for customer experience and consumer confidence to the customer experience/confidence lead. This person coordinates with the functional areas that manage customer and stakeholder touchpoints to establish plans, execute plans, and monitor results[152].

19. The Plans

There should be multiple plans that govern the activities of the project. Each of the functional areas will then have one or more plans that align with the customer experience plan[153]. Corporate communications will have a plan for messages, media and communications calendars, and so on. It is best that plans are developed around customer segments. The reasons for this are the varying needs of the different segments and the meter technology used by the different segments.

20. The Coordination

The deployment of smart meters is dynamic and fluid. There will be adjustments to even the best plans due to weather, outages, inventory shortages, consumer complaints, media attention, regulatory orders, and so on. Thus, it is imperative that the consumer confidence team meet regularly to monitor the development and execution of plans, and ensure the various functional areas are coordinated[154]. Regular meetings are the norm, with daily stand-up meetings suggested during key events (such as first week of meter deployment, launch of web portal, and so on).

21. Detailed plan[155][156]

IEC will therefore have a key role to play before, during and after the installation of smart meters. The rollout and related education and communication effort towards customers will encompass three different phases:

- Phase 1 – Preparation of the rollout
- Phase 2 – Installation of the smart meters
- Phase 3 – Post-installation: smart meter customer support, complaint handling and fault resolution

In this preparatory phase, IEC should aim to:

- Inform customers about the deployment of the new metering system and the advantages smart meters bring with respect to overall energy efficiency;

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[152] After THE SMART METER DEPLOYMENT HANDBOOK. NV Energy and U.S. Department of Energy, 2013
[152] Regulatory Aspects of Smart Metering.

[153] THE SMART METER DEPLOYMENT HANDBOOK. NV Energy and U.S. Department of Energy, 2013
[154] Ibid
[155] Based on "According to Communicating smart meters to customers– which role for DSOs?" A EURELECTRIC paper, June 2013

[156] According to "THE SMART METER DEPLOYMENT HANDBOOK." NV Energy and U.S. Department of Energy, 2013

- Inform public officials, the media, and other energy market players (ESCOs, suppliers, aggregators, etc.) who are likely to interact with customers during the deployment process;
- Provide a timeline of smart meter installations;
- Explain the process associated with the installation of smart meter;
- Clarify at a general level why the IEC is installing smart meters.

IEC will consider the following three aspects:

22. 1.Customer awareness and understanding of smart meter deployment

The communication materials should be clear, concise and drafted in a way that customers can reasonably be expected to understand them. The materials might include:

- A welcome letter
- Website
- Frequently Asked Questions

23. 2.Training and accreditation of the installers

- Rules for safety in low voltage to observe during installation work
- The installation instructions and process information should be well documented and taught to the installers
- The training material should recognize local specificities (e.g. metering solutions, wiring, tariff based load controls).

24. 3.Scheduling visits

When scheduling the smart meter installation time:

- The IEC agrees with the chosen contractor (if applicable) to carry out the installations at the installation time of a certain area.
- Some weeks before the planned installation the DSO sends a letter to those customers who will receive a new meter.
- The letter gives general information about the meter exchange and the changes it implies.
- A few weeks before the planned installation the contractor sends letters to those customers who need to be at home (onsite) during installation.
- Several days before the planned installation the contractor sends an information letter to those customers who do not need to be home (onsite) during meter exchange.
- It is recommended that soon after the installation process, customers are asked to respond to a customer satisfaction inquiry (via email, app, SMS, web-tool, etc.), and that this information is used to improve the advance information and the installation process.

IEC will install the meter and carry out appropriate tests:

25.Installation

- A site inspection could be undertaken before commencing any work at the installation visit and the customer is advised that the inspection will take place.
- Where appropriate, the installer gives the customer verbal guidance on safety and makes them aware of the risks of storing objects too close to or obstructing the meter.

- The customer is made aware of whom to contact after the installation visit for further information in relation to the smart meter installation for support, query resolution, or to provide feedback (verbally or in writing). Non-premium rate helpline numbers are provided.
- The customer is made aware of any additional sources of help and information, including helplines, websites and other appropriate organizations able to offer assistance.
- The IEC is responsible for defining the standards against which meter installers working for contractors are certified as competent for the task.

26. Installing the smart meter – what will happen when the smart meter is installed?

1. The IEC or the contractor (if applicable) will contact customers and let them know about a fixed period during which a qualified meter installer will come to remove the old meter and fit the new smart meter.

2. The installers will present and identify themselves. They will let the customer know when the work is about to begin and when it is finished. The customer will not be required to pay anything to the installer.

3. The power will be switched off for a certain time (usually 20 to 60 minutes) while the smart meter is installed.

4. Meter reading of the old and new meter.

5. The installer will leave the customer with instructions on how to read the new smart meter (including a safety manual) and details about whom to contact if case of problems.

6. In cases where the power control functionality of the smart meter is being implemented, instructions must be left so that the customer understands the new operation of power control and how to react when the demanded power exceeds the contracted one.

7. Suppliers will get in touch with consumers to offer innovative customer services (e.g. introduction of new type of contracts or products).

27. Testing and demonstration

To ensure the accuracy of its smart meters, the IEC has multiple test phases in place prior to, during and after installation.

- It is the IEC's responsibility to take appropriate steps to ensure the full smart metering system is operating correctly.
- The use of the smart metering system is demonstrated to the customer, including what information is available from the smart metering system and how this can be accessed.
- Instructions, in a written or other suitable format, on how to use the smart metering system are left with or sent to the customer.
- The demonstration of the smart metering system is responsive to the needs of vulnerable customers or others with specific needs.
- Essential information should be provided in a format suitable for vulnerable customers and those with specific needs.

- When the meter installers have changed the meter they can give the customer a hand-out (or leave a note in the customer's mailbox) with additional information. It is important to notify customers where they can get additional information if needed.

Customers do not necessarily need to receive all of the information mentioned in the previous section automatically (e.g. all benefits of smart metering, all new qualities of the meter, the distribution of installation costs). Instead, some information can be made available on the IEC web page. Alternatively, customers could contact a IEC customer service center if they would like to receive more specific information.

28. Customer feedback

It is the IEC's responsibility to ensure that:

- The customer has a means of providing feedback on their experience of the installation visit. This could be in the form of feedback card, via a website, email or verbally.
- A follow-up call or visit can be made to a demonstrably valid sample of customers from a variety of customer groups to learn from their experience of the installation visit. This information provides input for future installation visits and, where appropriate, for member policies and processes.
- The customer should possibly also receive written information about the reading of the replaced meter and the fact that a smart meter has been installed. It is also recommended that additional information on the meter itself is provided (information available on the display, etc.).

29. Resolving complaints

Customers should have clarity on whom to contact if they have queries or problems and where they can get redress. IEC should ensure that:

- Different communication channels (customer care center, web, offices, etc.) are put in place and trained to give an adequate level of support.
- Dedicated complaint handling and redress systems with appropriately trained staff are put in place ahead of rollout.
- The IEC makes every reasonable endeavor to take responsibility for the fault and the resolution.
- Suitable operational arrangements are in place with service providers and network operators so that complaints are addressed in a timely manner.
- If IEC use a contractor for installations, the processing and responsibilities concerning customer complaints must be clearly agreed between IEC and contractors.

30. Fault resolution

IEC should ensure that:

- Information is provided as to whom customers can contact if they identify a fault with the smart metering system.
- The customer is provided with contact details for additional information related to the smart metering system fault, for example should they wish to check progress.
- If a fault is identified with the smart metering system after the installation visit, the customer is made aware what the resolution is likely to be, who will be resolving the fault, and the approximate timescales of the resolution.

Conclusions. Smart metering by IEC is in the interest of customers.

- Metering is a crucial behind-the-scenes process, which is necessary for the smooth operation of all other market processes. Giving the IEC the sole responsibility for all metering sub-processes, including meter reading and validation, significantly reduces complexity and guarantees a smooth and efficient operation.
- Smart meter data collection and management by IEC enables effective privacy and security of customer data in a regulated environment.
- Smart meters enable IEC to measure power quality and interruptions. This is useful to solve problems in the network and to improve the quality of supply for customers.

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