Maximizing Energy Savings Reliability in
BC Hydro Industrial Demand-side Management Programs:
An Assessment of Performance Incentive Models

by

Nathaniel Gosman
B.A., Reed College, 1999

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Supervisory Committee

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Abstract

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For energy utilities faced with expanded jurisdictional energy efficiency requirements and pursuing demand-side management (DSM) incentive programs in the large industrial sector, performance incentive programs can be an effective means to maximize the reliability of planned energy savings. Performance incentive programs balance the objectives of high participation rates with persistent energy savings by: (1) providing financial incentives and resources to minimize constraints to investment in energy efficiency, and (2) requiring that incentive payments be dependent on measured energy savings over time. As BC Hydro increases its DSM initiatives to meet the *Clean Energy Act* objective to reduce at least 66 per cent of new electricity demand with DSM by 2020, the utility is faced with a higher level of DSM risk, or uncertainties that impact the cost-effective acquisition of planned energy savings. For industrial DSM incentive programs, DSM risk can be broken down into project development and project performance risks. Development risk represents the project ramp-up phase and is the risk that planned energy savings do not materialize due to low customer response to program incentives. Performance risk represents the operational phase and is the risk that planned energy savings do not persist over the effective measure life. DSM project development and performance risks are, in turn, a result of industrial economic, technological and organizational conditions, or DSM risk factors. In the BC large industrial sector, and characteristic of large industrial sectors in general, these DSM risk factors include: (1) capital constraints to investment in energy efficiency, (2) commodity price volatility, (3) limited internal staffing resources to deploy towards energy efficiency, (4) variable load, process-based energy saving potential, and (5) a lack of organizational awareness of an operation's energy efficiency over time (energy performance). This research assessed the capacity of alternative performance incentive program models to manage DSM risk in BC. Three performance incentive program models were assessed and compared to BC Hydro's current large industrial DSM incentive program, Power Smart Partners – Transmission Project Incentives, itself a performance incentive-based program. Together, the selected program models represent a continuum of program design and implementation in terms of the schedule and level of incentives provided, the duration and rigour of measurement and verification (M&V), energy efficiency measures targeted and involvement of the private sector. A multi criteria assessment framework was developed to rank the capacity of each program model to manage BC large industrial

DSM risk factors. DSM risk management rankings were then compared to program cost-effectiveness, targeted energy savings potential in BC and survey results from BC industrial firms on the program models. The findings indicate that the reliability of DSM energy savings in the BC large industrial sector can be maximized through performance incentive program models that: (1) offer incentives jointly for capital and low-cost operations and maintenance (O&M) measures, (2) allow flexible lead times for project development, (3) utilize rigorous M&V methods capable of measuring variable load, process-based energy savings, (4) use moderate contract lengths that align with effective measure life, and (5) integrate energy management software tools capable of providing energy performance feedback to customers to maximize the persistence of energy savings. While this study focuses exclusively on the BC large industrial sector, the findings of this research have applicability to all energy utilities serving large, energy intensive industrial sectors.

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Demand-side Management (DSM)
Measures to influence the energy use of consumers (e.g. to reduce energy use or alter patterns of energy use).

DSM Administrator
Utilities, government agencies and third-parties who plan, design and deliver demand-side management programs.

Energy Efficiency Measure (EEM)
A technology or practice that reduces the energy use of a building, device or system while maintaining a comparable level of service.

Energy Efficiency Service Provider
Energy service companies, engineering firms or equipment vendors who install, commission, and in some occasions finance and maintain, energy efficiency.

Energy Performance
The energy efficiency of a building, device or system over time.

Energy Savings Reliability
Certainty that energy efficiency and conservation measures will be adopted by consumers and result in persistent reduction of energy consumption.

Energy Service Company (ESCO)
Companies that provide energy services guaranteed in performance contracts and often financed through operational savings (e.g. repaid through the difference in pre and post implementation energy bills).

Ex Ante Energy Savings
Energy savings estimates determined via engineering calculation (e.g. based on standard wattage tables and operating hours) before implementation of an energy efficiency measure.

Ex Post Energy Savings
Energy savings determined through measurement.

Free Riders
Program participants who receive incentives for measures they would have otherwise undertaken in the absence of the incentive.

Measurement and Verification (M&V)
Methods for determining the energy savings resulting from energy efficiency measures as well as verifying they are operational and functioning as intended

Net Energy Savings
The difference in energy savings between a group of program participants and a comparable control group of program non-participants (e.g. net of free riders).

Net Participants
Program participants who would not have implemented an energy efficiency measure without an incentive.

Operations and Maintenance (O&M)
The optimization of schedules, procedures, system controls or equipment function, as well as the routine, predictive and preventive maintenance of equipment and systems.

Planned Energy Savings
Energy savings resulting from DSM programs, codes and standards, or rate structures that are included in utility integrated resource plans and thus relied upon to meet utility load requirements.

Abbreviations

BCUC: British Columbia Utilities Commission

CUSUM: Cumulative Sum of Differences

DSM: Demand-side Management

EEM: Energy Efficiency Measures

kWh: Kilowatt hour

FTE: Full-time equivalents

ESCO: Energy Service Company

GDP: Gross Domestic Product

GW: Gigawatt

GWh: Gigawatt hour

IPMVP: International Performance, Measurement and Verification Protocols

M&V: Measurement and Verification

MT&R: Monitor, Target and Report

NECPA: U.S. National Energy Conservation Policy Act

O&M: Operations and Maintenance

PSP-T: BC Hydro Power Smart Partners - Transmission Service Rate Programs

PSCRC: Public Service Conservation Resources Corporation

PUC: Public Utilities Commission

PURPA: U.S. Public Utilities Regulatory Policies Act

TRC: Total Resource Cost

UCT: Utility Cost Test

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Dedication

I dedicate this thesis to my wife, Sarah, and two sons, Julien and Jasper, for supporting me throughout this process with love and tolerance.

1 Introduction

1.1 BC DSM Policy Context

The British Columbia (BC) Government has simultaneously pursued a path of renewable electricity supply development and demand-side management (DSM) in order to bridge a growing electricity supply gap, reduce greenhouse gas emissions in the overall economy and increase its electricity export capacity. However, given siting concerns, escalating capital costs associated with new supply development and a commitment to energy efficiency, the BC Government has given precedence to the pursuit of cost-effective DSM in electricity planning. In 2010, the BC Legislature passed the *Clean Energy Act*, setting forth the expectation that BC Hydro reduce at least 66 per cent of new electricity demand with DSM by 2020. The Act defines DSM as a rate, measure, action or program undertaken to conserve energy or promote energy efficiency, to reduce the energy demand a public utility must serve, or to shift the use of energy to periods of lower demand (British Columbia 2010).[1]

1.2 BC Hydro DSM

BC Hydro, British Columbia's primary electric utility, serves an annual domestic demand of 50, 000 gigawatt hours (GWh) across all sectors (BC Hydro 2011). The utility has pursued a range of DSM resource acquisition and market transformation strategies in recent years, including the introduction of conservation-inducing rate structures, supporting higher efficiency building codes and equipment standards, and a variety of DSM program offerings. Together, these initiatives have results in approximately 500 GWh per year of annual energy savings from 2005-2009 (BC

[1] Does not include a rate, measure, action or program that encourages a switch to more carbon-intensive energy sources.

Hydro 2012). BC Hydro DSM programming, or Power Smart, includes a combination of information, energy management and technical enablers as well as financial incentives for energy efficiency measures (EEMs). In the large industrial sector, financial incentives represent the largest proportion of resources deployed to facilitate the implementation of EEMs by transmission service customers (BC Hydro 2009). Power Smart Partners – Transmission (PSP-T) Project Incentives are considered a key DSM resource acquisition tool in achieving energy savings within BC Hydro's industrial DSM portfolio, which as a whole represents the greatest annual achievable energy savings potential in the province.[2]

The large industrial sector in BC has historically been an area of challenge and opportunity for BC Hydro.[3] On the one hand, the large industrial sector is complex and does not lend itself to easily implemented and replicable energy efficiency measures (EEMs) given the unique configuration of processes, maintenance histories and organizational dynamics in each industrial operation. Similarly, the inclination of industrial firms to participate in DSM programs can vary widely in response to subsector market conditions (BC Hydro 2009a). On the other hand, the large industrial sector presents a high impact energy savings opportunity due to the small number of operations, large volume of electricity consumed and relatively low levels of investment in energy efficiency in some of the most energy intensive industries due to historically low energy prices.

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[2] According to the latest BC Hydro Conservation Potential Review (2007), upper achievable annual energy savings by 2021 in the Industrial sector = 4,849 GWh/year, Commercial Sector = 2,866 GWh/year, and the Residential Sector = 2,391 GWh/year. Note these estimates do not include potential savings from rate structures changes or codes and standards.

[3] The large industrial sector comprises raw material industries, heavy manufacturing industries that transform raw materials and manufacturing industries that produce finished goods. This study primarily focuses on the heavy manufacturing subsectors (NAICS 31-33) and mining subsectors (NAICS 21) which includes the quarrying, and oil and gas extraction subsectors. For more information on the North American Industry Classification System see http://www.statcan.gc.ca/subjects-sujets/standard-norme/naics-scian/2007/list-liste-eng.htm

As BC Hydro increases its DSM initiatives to meet aggressive provincial mandates, the utility is faced with a higher aggregate level of DSM risk, or uncertainties that impact the cost-effective acquisition of planned energy savings.[4] For industrial DSM incentive programs, DSM risk can be broken down into project development and project performance risks (Goldman and Kito 1995). Development risk represents the project ramp-up phase and is the risk that planned energy savings do not materialize due to low customer response to program incentives or that projects are not implemented successfully in customer facilities (Ibid.). Performance risk represents the operational phase and is the risk that planned energy savings do not persist over the effective measure life (Ibid.). DSM project development and performance risks are, in turn, a result of industrial economic, technological and organizational conditions, or DSM risk factors.[5] In the BC large industrial sector, and characteristic of large industrial sectors in general, these DSM risk factors include: (1) capital constraints to investment in energy efficiency, (2) commodity price volatility, (3) limited internal staffing resources to deploy towards energy efficiency, (4) variable load, process-based energy saving potential, and (5) a lack of organizational awareness of an operation's energy efficiency over time (energy performance). Given the significant increase in DSM initiatives expected of BC Hydro, an analysis of DSM risk management strategies used by other jurisdictions may be beneficial to BC Hydro as it considers future program design options.

[4] Planned energy savings are energy savings resulting from DSM programs, codes and standards, or rate structures that are included in utility integrated resource plans and thus relied upon to meet utility load requirements.

[5] See section 4.2 for details on the risk framework adopted in this study from *ISO standard 31000- Risk management Principles and Guidelines*.

1.3 Research Scope

This study assessed the capacity of alternative performance incentive program designs to manage DSM risk in BC. Performance incentive programs, also referred to as standard performance contract or pay-for-performance programs, attempt to balance the objectives of high participation rates with persistent energy savings. At the same time, performance incentive programs seek to transfer the risk of EEM underperformance away from ratepayers. They do this by providing financial incentives and resources to minimize constraints to investment in energy efficiency and requiring that incentive payments be dependent on measured energy savings over time (ex post energy savings). Performance incentive programs are also characterized to varying degree by three additional, not mutually exclusive program design elements (Nadel 1998; Schiller et al. 2000; CBP 2004):

- Program administrators offer a standard incentive rate per kilowatt hour (kWh) hour of energy saved available on a first-come, first-served basis, subject to utility resource availability.

- Participants (customers or third parties) guarantee energy savings in performance-based contracts that provide reimbursement of utility incentives if energy savings are not achieved.

- Inclusion of third-party energy efficiency service providers (energy service companies, engineering firms, equipment vendors) to market incentives and develop EEMs and ensure persistence of energy savings. Providers typically bundle the incentive into services offered to host customers and then enter into contracts with the utility to receive funds for energy savings resulting from the proposed projects.

Three performance incentive program models were assessed and compared to BC Hydro's current large industrial DSM incentive program, Power Smart Partners – Transmission Project Incentives, itself a performance incentive-based program. Summarized below and in Table 1, the selected performance incentive models represent a continuum of program design and implementation in terms of the schedule and level of incentives provided, the duration and rigour of measurement and verification (M&V), energy efficiency measures targeted and involvement of the private sector. An ideal research design would entail a selection of performance incentive programs from jurisdictions that have regulatory structures, industrial sector make-up and market characteristics similar to BC. As performance incentive programs meeting the criteria of this study did not all exist in comparable jurisdictions in the strictest sense, this was not an option. At a minimum, the selected programs are targeted at the large industrial sector, are ratepayer funded and share resource acquisition as a primary program objective.

(1) **New Jersey Public Service Enterprise Group (PSE&G) Standard Offer Program**

The Standard Offer program paid monthly incentives for measured energy savings from capital projects up to the full forecast avoided cost of supply. Contracts were five to fifteen years in duration and resembled energy purchase agreements. The program required continuous measurement and verification (M&V) of all energy efficiency measures for the duration of the contract. Energy efficiency service providers, who were eligible participants along with customers, played a key role in EEM implementation.

(2) **New York Energy Research & Development Authority (NSYERDA) Existing Facilities**

Formerly the Standard Performance Contract Program, Existing Facilities pays an incentive per kWh of energy saved from capital projects to offset costs beyond those associated with capital stock turnover (incremental cost). Incentive levels vary depending on end-use. The scope and cost of M&V is matched to the risk of the particular EEM, with some measures requiring only engineering analysis and verification. For measures requiring M&V, sixty per cent of the incentive is paid upfront with NYSERDA reserving the option to prorate the balance or require reimbursement following M&V. Contracts are two years in duration. The program places a strong emphasis on third party energy service company (ESCO) participation, with a mandate to support the development and expansion of the energy service industry in New York.

(3) **Bonneville Power Administration (BPA) Track and Tune Pilot Program**

Track and Tune provides incentives and assistance to industrial customers to implement energy performance tracking systems. The systems provide real-time energy performance feedback while also serving as an M&V platform to measure on going energy savings from operations and maintenance (O&M) improvements. Track and Tune pays an annual kWh incentive rate for O&M energy savings documented by the performance tracking system over three to five year contracts.

(4) **BC Hydro Power Smart Partners-Transmission (PSP-T) Project Incentives**

PSP-T Project Incentives pay a standard rate per kWh of energy savings for capital EEMs. The incentive is comprehensive, covering up to the total cost of the EEM. Ninety per cent of the incentive is paid during implementation based on engineering estimates of energy savings. The remaining balance is dependent on confirmation of energy savings from one year of post-implementation M&V. Contracts are 15 months in duration or less.

Table 1. Performance Incentive Program Overview

Performance Incentive Continuum	PSEG Standard Offer[6]	NYSERDA Existing Facilities[7]	BPA Track and Tune[8]	BCH PSP-T Project Incentive[9]
Years of administration	1993-1999	1998-present	April 2008 - present	November 2009 - present
Program objective	Resource acquisition	Resource acquisition; Market transformation	Resource acquisition	Resource acquisition
Target sectors	Large commercial and industrial	Large commercial and industrial	Industrial	Industrial
Incentive Design	• Comprehensive incentive (up to 100% of project cost) • Incentive paid monthly for energy saving documented through continuous M&V	• Incremental incentive (difference between high efficiency and standard efficiency measure) • 60-100% of incentive paid upfront upon verification of installation, with option to pro-rate balance or require reimbursement following one year or less of post-retrofit M&V	• Comprehensive incentive for performance tracking system paid upon verification of installation • Incremental O&M incentive paid annually for energy saving documented through continuous M&V	• Comprehensive incentive • 90% paid during implementation with option to pro-rate balance or require reimbursement following one year of post-retrofit M&V
Participant eligibility	Energy efficiency service provider, customer	Energy efficiency service provider, customer	Customer	Customer
Maximum contract duration	15 years	2 years	3-5 years	15 months
M&V protocol	New Jersey Measurement Protocol	IPMVP	IPMVP	IPMVP
End use mix	60% lighting; 27% fuel switching; 8% industrial process; 2% HVAC; 3% motors and drives	60% lighting; 20% HVAC; 20% motors, drives, compressed air and pumps	100% Operations and maintenance	10% lighting; 28% process; 15% pumps; 17% compressed air; 10% air displacement; 5%

6 Goldman et al. 1995; The Results Center 1994; Kushler and Edgar 1999; PSE&G, July 13th 2011

7 NYSERDA 2009; NYSERDA 2010; NYSERDA, March 4th 2011; NYSERDA, June 27th 2011

8 BPA 2009; BPA, June 21st 2011; BPA, June 24th 2011; BPA, October 25th 2011

9 BC Hydro 2009a; BC Hydro, August 3rd 2011

				conveyance; 2% motors and drives; 13% miscellaneous
Net annual energy savings (run rate)	1,100 GWh	558.3 GWh	~9.2 GWh	~107 GWh (with an additional 101.8 GWh in committed projects)
Program cost (constant 2011 dollars)	$325 million	$77 million	$326,659 to date	$7.6 million to date (with an additional $18.6M in committed projects)

1.4 Research Objectives

In comparing the selected performance incentive programs, this study asked: what is the potential effectiveness of alternative performance incentive program designs to minimize DSM risk, and thus maximize the reliability of planned energy savings, in BC Hydro industrial DSM incentive programs? Further to that question are the following ancillary research questions:

- Under what regulatory, utility, market and technological conditions did performance incentive program models evolve, and what are their defining attributes?
- What conditions increase risk around the development and performance of DSM projects in the industrial sector in general and BC specifically?
- What program design options are available to manage risk to development and performance?
- How do performance incentive program models address BC identified constraints to the development of DSM projects, transfer performance risk away from ratepayers, and support the persistence of energy savings from EEMs?
- How cost-effective are these programs and what would their targeted impact be if applied in BC?
- What is the response of industrial firms in BC to the different performance incentive program models?
- What alternative performance incentive program design options would suit the BC large industrial sector?

- What implications are there for industrial DSM programs in other jurisdictions?

The focus of this study on performance incentive programs is in large part a product of an eight-month MITACS internship co-sponsored by BC Hydro and Willis Energy Services Ltd. The internship focused on analysis of the programs included in this study as well as industrial and utility conditions affecting industrial energy efficiency efforts in BC. The internship culminated in a report presented to BC Hydro with recommendations for future industrial Power Smart incentive program design options.

1.5 Methods Summary

To assess the potential effectiveness and applicability of the selected performance incentive program models to maximize planned energy savings reliability in BC, evaluative criteria were developed to rank development and performance risk management strategies across the programs. The criteria indicate the degree to which program attributes in each performance incentive program model have the capacity to manage DSM risks identified in BC. DSM risk management rankings were then compared to program cost-effectiveness, targeted energy savings potential and feedback from BC industrial firms on the program models.

1.6 Chapter Outline

Chapter 2 provides performance incentive program case studies embedded in a broader history of performance incentive program design. Four generations of performance incentives programs are detailed, including DSM bidding, standard offer, standard performance contract and data-driven pay for performance programs. For each generation, the regulatory, utility, market and technological conditions that shaped the evolution of performance incentive programs are highlighted. The program case studies and program design history are used to highlight key program attributes that are assessed in Chapter 6 as well as illuminate the background in which each program design developed. It is argued that performance incentive programs share a design imperative to balance high participation rates and persistent energy savings that is rooted in integrated resource planning and expanded jurisdictional energy efficiency requirements.

Chapter 3 provides a general literature review of energy efficiency incentives as background to the assessment of performance incentive programs. The objectives of energy efficiency incentive programs are first considered, specifically contrasting resource acquisition with market transformation objectives. A typology of energy efficiency measures and incentives is then detailed and program types assessed with respect to the industrial sector. It is argued that, of all the incentive program types, performance incentives are best suited to the industrial sector because of the broad range of energy savings potential they can target and the certainty of energy savings they provide. The chapter concludes with a basic framework of program considerations that emerge from resource acquisition-based energy efficiency incentive programs. The first consideration is DSM development, or how programs maximize cost-effective participation while limiting free riders. The second consideration is DSM performance, or how programs maximize and ensure the persistence of energy savings. The latter framework will be used in Chapter 4 to inform the consideration of industrial DSM risk and risk management options.

Chapter 4 develops the analytical framework used to assess the performance incentive programs. The concept of energy savings reliability is first reviewed with respect to resource acquisition objectives. DSM risk, or uncertainties that impact the cost-effective acquisition of planned energy savings, is then defined. *ISO 31000 - Risk Management Principles and Guidelines* is then considered and its framework for identifying risk factors, events and impacts, and prescribing related risk management options is adopted. Next, Goldman and Kito's (1995) DSM risk framework detailing DSM development and performance risks is presented. Goldman and Kito's framework is applied to the large industrial sector and DSM risk factors and risk management options are identified. Next, BC industrial DSM risk is considered and key development and performance risk factors are identified. Together, the industrial DSM risk factors and risk management options are used in Chapter 5 (Methods) to develop the performance incentive program assessment criteria.

Chapter 5 details the methods used in this study. First the objective of the analysis and the intended audience are defined. The multi-criteria program model assessment methodology is then described. Next, BC DSM risk management criteria are developed in relation to the BC industrial DSM risk factors and associated DSM risk management options reviewed in Chapter 4. Data sources and collection methods are then described.

Chapter 6 presents the results of the performance incentive program model assessment. The programs are ranked with respect to DSM development and performance risk management. Rankings are then compared to program cost-effectiveness and targeted energy savings potential in BC. Finally, feedback from BC industrial firms on the program models is detailed.

Chapter 7 discusses the results of the performance incentive program model assessment. Of the programs considered, the DSM risk management criteria analysis indicates the Standard Offer and Track and Tune performance incentive models offer the greatest potential to effectively manage DSM risk in BC, and thus result in reliable energy savings. However, this potential comes at a cost in terms of limited energy savings potential in the case of Track and Tune which focuses exclusively on O&M measures and at a cost premium in the case of the Standard Offer. The chapter argues that beyond the individual program models, however, there is an opportunity to combine performance incentive attributes that scored highest in their respective risk management categories into alternative program designs that may broaden energy savings potential and achieve synergies in energy savings reliability and cost-effectiveness. The program model assessment indicates the following key program attributes have the greatest potential to manage DSM risk in the BC large industrial sector: (1) incentives offered jointly for capital and low-cost O&M measures that are structured to address capital constraints in each subsector, (2) flexible lead times for project development, (3) rigorous M&V methods capable of measuring variable load, process-based energy savings, (4) moderate contract lengths that align with effective measure life, and (5) energy management software tools capable of providing energy performance feedback to customers to maximize the persistence of energy savings and streamline M&V. Accordingly, alternative performance incentive program models synthesizing the highest-ranking program attributes were then identified. The models include: (1) a performance tracking system-based, open end-use standard offer model, and (2) a performance tracking system-based, open end-use project incentive model. It is argued that the potential benefits of both approaches include a combination of addressing customer constraints to energy efficiency investment, rigorous but streamlined M&V, and the enabling of energy system performance feedback.

Chapter 8 summarizes the research objectives, DSM risk framework, key findings of the model assessment and alternative performance incentive options. Future areas for research are then identified, including: (1) how to address organizational and technological barriers to the broad adoption of performance tracking systems in the BC large industrial sector, (2) follow-up studies to determine the persistence of O&M savings in industrial performance incentive programs, and (3) the development of best practices for how DSM administrators can use performance tracking system to integrate resource acquisition programs and energy management initiatives. Finally, the implications of the results and recommendations for the large industrial DSM beyond BC are considered. It is argued that as in BC, performance incentive program models can offer an effective means of managing both project development and performance risk in the industrial sector. The selection of program attributes will depend in part on industrial sector conditions in each jurisdiction. For development risk management strategies, market conditions and input costs, and resulting capital constraints, will be factors to consider in each subsector. M&V-based performance risk management options are likely to be similar across all jurisdictions given the universality of variable load, process-based energy saving potential in the large industrial sector. The performance tracking system offers a streamlined and auditable platform that enables persistent savings for both capital and O&M DSM. Moderate contract terms (i.e. two to five years) will be effective at ensuring the persistence of energy savings from industrial DSM projects as they are aligned more closely with measure life than short-term contracts.

2 Performance Incentive Program Design Background

2.1 Introduction

This chapter provides performance incentive program case studies embedded in a broader history of performance incentive program design. The history details four generations of performance incentive program design, starting with their origin in integrated resource planning in the 1980s, DSM bidding programs in the late 1980s, the Standard Offer program in the late 1990s, Standard Performance Contract programs from the late 1990s to today and finally, data-driven pay for performance programs in the past few years. For each generation, the regulatory, utility, market and technological conditions that shaped the evolution of performance incentive programs are detailed. The program case studies and program design history are used to highlight key program attributes that are assessed in Chapter 6 as well as illuminate the background in which each program design developed. Ultimately, it is argued that performance incentive programs share a design imperative to balance high participation rates and persistent energy savings that is rooted in integrated resource planning and expanded jurisdictional energy efficiency requirements.

Energy utilities, government agencies and third-party DSM administrators (henceforth DSM administrators) in the U.S. and Canada have administered non-residential performance incentive programs for the past 20 years. Performance incentive programs have primarily targeted the large commercial and industrial sectors, providing incentives for a range of custom capital and O&M EEMs. Over the years, the programs have evolved in response to regulatory shifts, changing market conditions and technological advancement. Some program attributes and concepts have remained relatively unchanged over time and others have been modified to meet new objectives, take advantage of new technologies or have been discarded altogether. Those durable program attributes include providing financial incentives tailored to reduce barriers to investment in EEMs, requiring that incentive payments be dependent on measured energy savings over time and in some programs, including energy efficiency service providers (energy service companies, vendors, engineering firms) as eligible participants (Schiller et al. 2000; CBP 2004). Energy efficiency service providers are used to leverage expertise and specialization in project development across multiple industrial energy consumers and ensure project performance. New program concepts include adoption of energy performance tracking systems and links to energy management initiatives to ensure the persistence of energy savings from EEMs (BPA 2009).

2.2 Origin of Performance Incentive Programs (1980-1985)

The origin of DSM programs in North America, including performance incentive programs, can be traced back to the U.S. *National Energy Conservation Policy Act* (NECPA) (Eto 1996). Signed into law in 1978, NECPA is the underlying authority for U.S. federal energy management goals and requirements (U.S. DOE 2012). In the midst of escalating energy cost during this period, NECPA's initial focus was enabling a requirement that regulated utilities offering energy audits to residential customers in order to accelerate the implementation of EEMs (Ibid.). Many utilities looked to the private sector to help meet their new mandates (U.S. EPA 2007). In response, ESCOs were formed to host the range of services required by utilities. To begin with, ESCO services included the "turnkey" provision of energy audits to identify EEMs, project financing, and implementation of EEMs (Ibid.) M&V in this period was typically based on a verification of services delivered rather than kWh saved (Ibid).

Integrated resource planning requirements mandated by state public utility commissions (PUC) in the late 1980s further set the stage for performance incentive programs (Ibid.). Integrated resource planning (IRP), also called least-cost planning, required regulated utilities to consider cost-effective demand-side measures to meet incremental annual load growth (Goldman and Eto 1998; Schiller et al. 2000). IRP emerged in response to the U.S. federal government's *Public Utilities Regulatory Policies Act* of 1978 (PURPA), which required utilities to buy power from non-utility generators that was less than their posted cost of supply (Eto 1996). PURPA initiated a broader shift in the utility energy planning process such that all cost-effective options competed as potential system resources, whether utility generation, renewable generation developed by independent power producers or energy efficiency and conservation measures (Ibid.)

2.3 First Generation: DSM Bidding (1987-1997)

DSM bidding programs were used by utilities in the late 1980s and early 1990s in response to integrated resource planning requirements and in the context of growing ESCO capacity to provide energy services (U.S. EPA 2007). Approximately 30 utilities conducted DSM bidding programs between 1987-1997 (Schiller et al. 2000). The programs relied primarily on ESCOs to market program offers and provide turnkey services to customers (Ibid.). A new generation of ESCOs emerged to provide these services at scale, primarily to commercial, institutional and industrial customers (Nadel and Geller 1996). Given the reconceptualization of DSM as a system planning resource in the IRP framework, "pay for performance" was a core principal in these programs (CBP 2004). As such, performance contracts that guaranteed energy savings were a key program requirement. Performance contracts were either with the utility or customer, or both parties. ESCOs proposed EEMs and then bid against other service providers, and sometime independent power producers, for the lowest cost kWh (Nadel and Geller 1996). Winning ESCOs then received an incentive for documented kWh or kW savings for EEMs implemented at customer sites (and/or they received payments from the customer based on a percentage of actual energy savings) (Nadel 1999).

Notably, utilities and ESCOs during this period struggled to develop replicable and streamlined M&V systems that could accurately account for energy savings across different technologies (U.S. EPA 2004). Complex M&V was a vexing problem in the first generation of performance incentive programs which set the stage for future M&V protocols (U.S. EPA 2007). Procurement and contract development was also problematic for the first generation of performance incentive programs. For example, ESCOs grew wary of participating in the programs for fear of losing their initial up-front project development and marketing costs if their bid was not accepted (Goldman et al. 1995). Performance contracts were not standardized and required utilities and ESCOs to enter into long negotiations (Schiller et al. 2000). The terms of the contracts could vary widely depending on the nature of the EEM being implemented and separate customer agreement with the ESCO (Ibid.) The cost burden of M&V, high transaction cost for bidding and contract preparation ultimately led the first generation of performance incentive programs to largely fall out of favour by the early 1990s (Ibid.).

2.4 Second Generation: Standard Offer (1993-2000)

The second generation of performance incentive programs emerged in 1993 with PSE&G's influential Standard Offer. The Standard Offer was the first DSM program to incorporate the pay for performance model of earlier DSM bidding programs, while streamlining the procurement process through the use of posted prices for delivered energy savings, standardized contract terms, and pre-specified M&V protocols (Goldman et al. 1995). Qualified participants, primarily ESCOs, submitted projects to PSE&G on a first-come, first served basis subject. As in the earlier generation of performance incentive programs, ESCOs were considered essential to project development as they helped market the program, provided for or arranged for upfront financing, provided performance guarantees to host customers and brought turnkey technical capacity

(Goldman et al. 1995). As with all eligible participants, ESCOs were responsible for EEM implementation, performance and maintenance, and received payments directly from PSE&G for measured energy savings.

The Standard Offer's primary program design objective was to ensure DSM resources were as reliable as supply-side resources – to build a "DSM power plant," using PSE&G words (The Results Center 1994). Contracts between participants and PSE&G resembled long-term energy purchase agreements, with PSE&G paying incentives up to the forecast avoided cost of supply (Ibid.). The DSM power plant imperative was echoed in the newly established *New Jersey Measurement Protocol* used in the Standard Offer. The protocol developed by the New Jersey Board of Public Utilities instructed utilities to measure DSM energy savings with the same standard of accuracy as supply-side resources to the extent possible. The standard protocol helped to reduce the cost of developing M&V plans that plagued the earlier generation performance incentive program (Ibid.; U.S. EPA 2007).[10] To ensure real and persistent energy savings, all EEMs required between five and fifteen years of continuous M&V (The Results Center 1994). Participants were required to guarantee an estimated range of energy savings over the contract term. If savings fell below a specified threshold, PSE&G reduced payments to the participants.

[10] That said, the New Jersey Measurement Protocol was ultimately found to be onerous and expensive by program participants who were responsible for developing M&V plans based on Board of Public Utilities guidelines, metering and submitting monthly operating report. Non-lighting measures required a custom M&V plan to be developed by participants and approved by PSE&G. The costs and risk associated with these plans, which were prone to utility processing delays and requests for re-engineering on occasion, were perceived to be considerable. Kushler and Edgar (1999) attribute the dominance of lighting measures in the program in part to the cost burden of M&V.

Table 2: PSE&G Standard Offer Program Details

Eligible Applicants • Energy service providers, commercial and industrial customers
Measure Eligibility • Any piece or system of equipment or material (electric or gas) that improved energy efficiency and could be measured and verified • Minimum acceptable proposal constituted at least 100 kW of "summer prime period average demand" reduction for at least 5 years
Project Implementation • Energy service providers, commercial and industrial customers
Contract length • 5, 10 or 15 years
Incentive • A time differentiated ¢/kWh incentive up to 100% of PSE&G's projected avoided costs (based on time of day and season) paid monthly for the duration of the contract • Two incentive options: unlevelized - incentive rate varied for each year of the contract term in relation to the projected avoided cost of supply, escalating over the term of the contract; levelized - incentive rate is the same amount for each year of the contract term
M&V • M&V plans submitted by participants; pre-implementation, implementation and annual post-implementation audits conducted by PSE&G (at their discretion) • Continuous long-term metering conducted by participant at every site for all EEMs • PSE&G reduced payments to participant if savings fell below a specified threshold

Source: Goldman et al. 1995; The Results Center 1994; Kushler and Edgar 1999

PSE&G's Standard Offer was offered in three consecutive phases, Offers 1-3, from 1993-1999. Notably, a handful of Standard Offer projects are still operational to this day, with fifteen-year contracts terminating in 2015. Standard Offer 1 (1993) was considered successful, with broad participation and sizeable cost-effective energy savings and peak reduction (Kushler and Edgar 1999). The program was attractive to many customers and ESCOs due to the competitive incentives (Ibid.). Standard Offer 2 (1995) was smaller than its predecessor and saw significantly lower participation rates due to a 27 per cent reduction in incentive levels to reflect a decline in utility avoided costs of supply (Ibid.). Standard Offer 3 (1999) was less than half the size of Offer 2, was oversubscribed by July of 2000 and subsequently closed as New Jersey embarked upon electricity deregulation. [11]

An evaluation of both Standard Offer 1 and 2 completed in 1998 reported that the program accounted for 1100 GWh of annual net energy savings and 200 MW of summer peak demand reduction (Ibid.). The program was estimated to cost $325 million during this period (2011 dollars) and was found to be cost-effective with an overall total resource cost test benefit-cost ratio (TRC) of 1.37 (Ibid).[12] Of the energy savings, virtually all from electric EEMs, approximately 37 per cent were in industrial facilities. In the large commercial and industrial sectors, 60 per cent of energy savings were from lighting measures, 27 per cent from fuel switching, 8 per cent from industrial process measures, 3 per cent from motors and drives, and 2 per cent from HVAC improvements.

In 1999, the New Jersey state legislature passed the *Electric Discount and Energy Competition Act* which set the course for retail competition in the state. According to Martin Kushler and George Edgar, who performed an evaluation of the Standard Offer and later reflected on the program in a paper for the 1999 International Energy Program Evaluation Conference, uncertainty about how large utility-based resource acquisition programs should be funded and administered in a restructured environment was a significant factor in the program's discontinuation (Ibid.). Martin and Kushler further argued that had restructuring not occurred and utilities still operated under the IRP paradigm, programs like the Standard Offer would still be

[11] This study focuses on Standard offer 1-2, as they are considered the primary phases of the program and data for Offer 3 is limited.

[12] See section 5.2.3 for a description of the total resource cost test.

seeing widespread application given its success in acquiring large-scale energy savings (Ibid.). The accuracy of that observation is debatable in light of the relative cost premium of paying incentives up to the forecast avoided cost of supply over long-term contracts and requiring continuous M&V for all measures. While the Standard Offer achieved its goal of acquiring real and persistent energy savings, compared to contemporary performance incentive programs which offer incentives based on incremental costs and employ M&V that is typically less than two years, the Standard Offer appears to be excessive.

2.5 Third Generation: Standard Performance Contract (1998-Present)

The third generation of performance incentive programs introduced in 1998 built on the model of the PSE&G's Standing Offer while adopting a more conservative and further streamlined approach (Schiller et al. 2000). The NYSERDA Standard Performance Contract Program, renamed Existing Facilities in 2009, and notably the California Statewide Standard Performance Contract Program, renamed Customized Offering in 2009, are well established and documented examples of third generation performance incentive programs (Ibid.). These programs, both administered to this day, pay a standard rate per kWh of energy savings (or kW of capacity savings) from capital projects in the large non-residential sectors to partially offset incremental costs. Eligible participants include customers and energy efficiency service providers (primarily ESCOs, but also engineering firms and vendors). Both programs utilize contracts that are no more than two years to align with DSM budget cycles (Goldman et al. 1998; NYSERDA, March 4th 2011). The programs use standardized M&V protocols for all measures and match the scope and cost of M&V to the risk of the particular EEM, with some measures requiring only engineering analysis and verification (Ibid.). Current program objectives include resource acquisition and to a lesser degree, market transformation.[13]

The streamlined approach taken by NYSERDA and California Statewide Standard Performance Contract programs has its genesis in shifting policy imperatives created by electric industry restructuring in the U.S. during the latter part of the 1990s (Schiller et al. 2000). As New York and California prepared to transition into retail electricity competition, the state's Public Utility Commissions encouraged DSM program administrators to integrate market transformation strategies into DSM programs design (Goldman et al. 1998; Eto et al. 1998; Schiller 2000). At the time, market transformation objectives were focused on supporting the development and expansion of a robust and competitive energy service industry which was viewed as an exit strategy for utility and third-party administered DSM. These efforts focused primarily on ESCOs (Schiller et al. 2000). ESCOs were considered instrumental in maintaining the societal benefits of large non-residential energy efficiency efforts post-utility DSM based on their capacity to arrange for financing and provide EEM performance guarantees (Ibid). To this end, program streamlining served to encourage greater participation from the energy service industry as well as offset the dampening effect of reduced incentive levels (Ibid).

Ultimately both programs persevered beyond their initially intended transition periods, enduring restructuring efforts which ended prematurely in the case of California following the 2001 energy crisis. Although significantly streamlined, the Standard Performance Contract program model continues to be a large part of DSM portfolios in both states given increasingly aggressive energy efficiency requirements. As the California Statewide and NYSERDA programs are very

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[13] See section 3.3 for details on resource acquisition and market transformation program objectives.

similar in program design, this study elects to focus on NYSERDA's Existing Facilities given its distinctive focus on energy efficiency service providers.

NYSERDA - Existing Facilities Program

Incentives for energy projects delivering verifiable annual electric energy and capacity savings are provided through a "standard performance contract" between NYSERDA and participating energy efficiency service providers or customers. Similar to performance contracts used in the Standard Offer, standard performance contracts stipulate that EEMs requiring M&V will have incentive levels adjusted based on the M&V results (NYSERDA 2009). Unlike the Standard Offer, 60 per cent of the incentive is provided upfront based on engineering estimates to minimize participant capital constraints. NYSERDA reserves the option to prorate the balance or require reimbursement following M&V. Although beyond the scope of the program, it was noted by a program administrator that energy service participants typically enter into either an energy performance contract or a fee-for-service contract with host customers (NYSERDA, March 4th 2011). The amount of the incentive passed through to the customer is negotiated between the contractor and the customer (Ibid.).

By virtue of the PUC mandate to support the development and expansion of the energy service industry, Existing Facilities initially offered performance-based incentives exclusively to ESCOs. As in the Standard Offer, participating service providers are responsible for EEM implementation and performance and receive payment directly from NYSERDA for calculated or measured energy savings. Over the course of the 2000s, short-term resource acquisition eclipsed market transformation program objectives as the New York Public Service Commission imposed increasingly aggressive energy efficiency requirements on NYSERDA in response to escalating supply costs and greenhouse gas emission reduction objectives (NYSERDA, March

4th 2011).[14] As a result, in 2009 Existing Facilities included customers as eligible participants in an effort to widen the scope of the program and make it more flexible to participants with exiting capacity to implement projects (Ibid.).[15]

Table 3. NYSERDA Existing Facilities Program Details

Eligible Applicants • Commercial and industrial customers, energy efficiency service providers
Measure Eligibility • Hard-wired electric and natural gas efficiency measures, monitoring-based commissioning (O&M), energy storage, combined heat and power, and demand response measures • Must achieve energy or capacity savings for at least 5 years; no minimum payback required for industrial EEMs; must qualify for incentive of at least $30,000
Project Implementation • Commercial and industrial customers, energy service providers
Contract length • < 2 Years
Incentive • For EEMs not requiring M&V, 100% of a ¢/kWh incentive is paid after post-installation inspection • For EEMs requiring M&V, 60% of a ¢/kWh incentive is paid upon installation and the balance after NYSERDA receives and approves the final M&V report • For industrial EEMs, incentives are based on one year's energy savings; on average, incentives contribute eighteen per cent towards total project costs
M&V • M&V required for lighting projects that provide annual energy savings greater than 1000 MWh or non-lighting EEMs that provide annual energy savings greater than 500 MWh • Participant submits an M&V plan; pre and post-installation inspection by utility; up to two years of M&V conducted by participant for measures where the reliability and persistence of savings are not certain culminating in an M&V report submitted by participant • Projects failing to achieve specified energy savings may have final incentive levels prorated or be required to reimburse NYSERDA for overpayment

Source: NYSERDA 2009; NYSERDA 2010; NYSERDA, March 4th 2011; NYSERDA, June 27th 2011

[14] In 2008, the New York Public Service Commission approved an Energy Efficiency Portfolio Standard that requires the state to reduce electricity consumption by 15 per cent below projected levels by 2015.

[15] Energy service providers of all categories continue to provide a key role in project development by marketing incentives and bringing turnkey technical capacity. Approximately 85 per cent of current participants are energy service providers (NYSERDA, March 24th 2011)

Existing facilities consists of two primary offerings: pre-qualified incentives (rebates) and performance-based incentives. The performance incentives are price differentiated for specific applications, including: (1) electric efficiency, (2) energy storage, (3) natural gas efficiency, (4) combined heat and power, (5) demand response, (6) monitoring-based commissioning, and (7) industrial and process efficiency. On average, program incentives contribute 18 per cent towards total project costs (NYSERDA 2010). From July 2006 to December 2009, NYSERDA reported Existing Facilities achieved 558.3 GWh of net annual energy savings, with a program cost of $77 million (2011 dollars) and a TRC benefit-cost ratio of 1.5 (NYSERDA 2010). 96 per cent of energy savings were from electric EEMs. In discussion with a program administrator, it was reported that 90 per cent of total Existing Facilities energy savings are attributable to performance-based incentives, of which 60 per cent were from lighting measures, 20 per cent from HVAC and 20 per cent from motors, drives, compressed air and pump improvements. 20 per cent of total energy savings were from the industrial sector (NYSERDA, June 27th 2011).

The M&V requirements for NYSERDA's Standard Performance Contract program, now Existing Facilities, were considerably streamlined compared to the PSE&G Standard Offer which preceded it. The development of the International Performance Measurement and Verification Protocol (IPMVP) in the late 1990s which was adopted by NYSERDA is credited in part with reducing the cost burden of M&V in utility programs of this era (U.S. EPA 2007; NYSERDA, March 4th 2011).[16] Unlike the New Jersey M&V protocol, The IPVMP provides flexible M&V options and procedures designed to match program costs, energy saving magnitudes, uncertainty, as well as address technology-specific characteristics and requirements (EVO 2010). That said, the Standard Performance Contract program was still relatively rigorous

[16] See section 4.4.2 for details on IPMVP

in the early years of the program. For the first three years, up to two years of M&V was required for all EEMs regardless of end-use (NYSERDA, March 4th 2011). M&V guidelines initially prohibited the use of stipulated savings calculations (Schiller et al. 2000). According to one program administrator, rigorous M&V built the early credibility of the program. It was reported that energy service providers were initially in favour of the rigorous M&V, as it was perceived to give them an edge over competitors in terms of providing reliable energy savings (NYSERDA, June 27th 2011).

Over time, however, M&V procedures were further streamlined to maintain program participation in response to participant feedback indicating M&V requirements were considered too costly and time-intensive (NYSERDA, March 4th 2011). Additionally, through many hours of experience and a wealth of data, energy use characteristics on various common EEMs such as lighting improvements, historically 60 per cent of the program's end-use mix, became well known (Ibid.). With this knowledge, energy use parameters could be stipulated to varying degrees without significant risk to overall energy savings reliability and consequently, M&V requirements for common measures were relaxed (Ibid.; Schiller et al. 2000).

Performance Contract program models have been influential beyond California and New York, with a number of large non-residential utility DSM incentive programs adopting similar third generation performance incentive attributes over the 2000s. In Canada, examples of these programs currently include Ontario Power Authority's Industrial Accelerator Program and BC Hydro's Power Smart Partners Distribution and Transmission Project Incentives, the latter which forms the baseline for this study and is summarized below.[17]

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[17] Unfortunately no data is available for Industrial Accelerator to date as it was introduced in 2010.

BC Hydro Power Smart Partners - Transmission (PSP-T) Project Incentive Program

BC Hydro PSP-T Project Incentives provide a standard rate per kWh of energy savings to large industrial customers to implement hard-wired capital EEMs. BC Hydro notes that the program's primary objective is direct energy savings acquisition given the utility's requirement in the *Clean Energy Act* to reduce at least 66 per cent of new electricity demand with DSM by 2020 (BC Hydro 2009a). BC Hydro's strategy for acquiring firm energy savings is to provide a comprehensive incentive with minimal cash flow impact to customers (Ibid). Unlike Existing Facilities where incentives are provided for a portion of incremental EEM costs, PSP-T Project Incentives pays up to 100 per cent of eligible projects costing $1 million or less, with 90 per cent of incentives paid during implementation. The remaining balance is dependent on confirmation of energy savings from post-implementation M&V. Like NYSERDA, BC Hydro reserves the option to prorate the balance or require reimbursement following M&V (Ibid.). The incentive covers most costs associated with implementing EEMs, including engineering design, equipment acquisition, equipment installation, in-house labour, project management, disposal, and taxes (Ibid). Energy efficiency service providers are not eligible to participate directly in the program, though BC Hydro maintains a network of independent contractors and engineers it provides referrals to as needed (Ibid.).[18] BC Hydro ensures the performance of EEMs by requiring up to one year of continuous M&V for most projects (BC Hydro, August 3rd 2011). Contracts for energy savings are a maximum of 15 months which harmonizes with BC Hydro's two-year DSM plan expenditure cycle (Ibid.).[19]

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[18] The Power Smart Alliance

[19] Regulatory and funding uncertainty beyond budget cycles in general creates a disincentive to adopt longer-term DSM program models for utilities (Nadel 1996).

Table 4. BC Hydro PSP-T Project Incentives Program Details

Eligible Applicants • Industrial customers
Measure Eligibility • Hard-wired facility upgrades achieving at least 300 MWh/yr with an expected lifespan of five years or more and a minimum payback of one year
Project Implementation • Industrial customers
Contract length • 1 year
Incentive • Projects costing $1 million or less are eligible for incentives up to 100%; projects costing more than $1 million are eligible for incentives up to 75%; maximum incentive is calculated based on the amount of electricity a project will save over its projected lifetime • Up to 90% of the incentives being paid during implementation with the remaining balance paid following M&V
M&V • Pre and post-installation inspection; up to one year of continuous post-retrofit M&V with BC Hydro reserving the option to prorate the final incentive levels based on M&V results; M&V is conducted by BC Hydro

Source: BC Hydro 2009a; BC Hydro, August 3rd 2011; Power Smart Website, August 28th 2011

BC Hydro's current PSP-T Project Incentives were introduced in 2008 following a pause in incentive-based programming during the introduction of the two-tiered Transmission Service Rates in 2007 (BC Hydro 2009a.). The Transmission Service Rate structure provides an elevated price signal (Tier 2) at 90 per cent of an industrial customer's annual electricity consumption baseline. Tier 2 is intended to create an incentive for customers to undertake EEMs to avoid having to pay the higher rate (BC Hydro 2009b). It has been reported that the Transmission Service Rate structure was effective in incenting industrial customer to undertake a high volume of O&M projects when first introduced (BC Hydro 2009a). This is reflected in the minimum volume of Tier 2 electricity currently consumed by transmission service customers (Ibid.). To date, most transmission customers are at or near ninety per cent of their baseline (Ibid.). Notably, if customers fall below ninety per cent, or above one hundred and ten per cent, of their annual baseline, it is reset the following year - an outcome transmission service customers seek to avoid given the implication of having to pay a greater percentage of electricity consumption at Tier 2 (BC Hydro 2009b).

While the Transmission Service Rate was effective at achieving O&M savings during the 2007-2008 period, PSP-T customers implemented few capital EEMs (BC Hydro 2009a). The lack of capital projects was partly attributed to the value proposition of EEM investment reflecting the lower Tier 1 rate avoided energy cost (Ibid.). A 2¢ per kWh Project Incentive was reintroduced in 2008 to PSP-T customers in an attempt to move the industrial market to implement EEMs (Ibid.). This proved ineffective at minimizing capital barriers for industrial customers (Ibid.). In late 2009, Project Incentives were increased to 4.5¢ per kWh and have since resulted in thirty-nine projects representing an estimated 107 GWh in net annual energy savings with an additional 101.8 GWh in committed projects (BC Hydro, August 3rd 2011). The program has cost $7.6 million to date with an additional $18.6M in committed projects and has and an estimated TRC benefit-cost ratio of 2.6 (Ibid.).

In some respects, PSP-T Project Incentives represent a hybrid of the Standard Offer and Existing Facilities model. Like the Standard Offer, BC Hydro requires rigorous M&V across most projects. Of 42 current projects, all are currently in continuous post-implementation M&V (Ibid.). This is partly attributed to exclusive focus of PSP-T on large industrial end-uses: 28 per cent of current PSP-T EEMs are process improvements, followed by compressed air (17%) and pump upgrades (15%) – compared to the relatively high percentage of lighting measures in both PSE&G and NYSERDA (Ibid.). Like the Standard Offer, PSP-T Project Incentives pay a rate that is substantially higher than incremental costs. Finally, unlike the Standard Offer, and similar to Existing Facilities, PSP-T Project Incentive pay a substantial portion of the incentive up front based on engineering analysis, with the balance trued-up to M&V results. This latter program design features is seen as a critical attribute to minimize capital constraints in the BC large industrial sector (BC Hydro 2009a).[20]

2.6 Fourth Generation: Data-driven Pay for Performance (2009-Present)

The fourth generation of performance incentive programs incorporate energy management information systems into a pay for performance program model. These programs, for example BPA's Track and Tune Program, NYSERDA's Industrial and Process Efficiency O&M incentives and New Jersey Clean Energy's Pay for Performance Commercial and Industrial Existing Buildings Program, provide incentives to large non-residential customers to implement performance tracking systems and implement O&M EEMs (BPA 2009; NYSERDA 2009; Healey et al. 2010). The performance tracking systems provide the benefit of energy performance feedback to customers that enable O&M improvements and broader energy management practices (e.g. allowing firms to benchmark energy performance, set performance targets, identify energy efficiency opportunities). At the same time the tracking systems serve as an M&V platform to ensure energy savings from O&M EEMs are persistent (Ibid.). The programs were developed in response to jurisdictional energy efficiency requirements that compelled program administrators to seek measurable, long-term energy savings from previously untapped, non-capital opportunities (NYSERDA, March 3rd 2011; BPA 2009; Chittum et al. 2009).[21] Additionally, the current economic downturn has created a need for utilities to offer non-capital based energy efficiency incentives to appeal to customers who are at the low end of

[20] BC large industrial sector capital constraints are detailed in section 4.5.

[21] For example the New York State Energy Efficiency Portfolio Standard or the Northwest Power and Conservation Council's Sixth Northwest Conservation and Electric Power Plan.

their business cycles (BPA 2009). This study focuses on Track and Tune as it represents the most rigorous program of its description targeting industrial EEMs.

Bonneville Power Administration - Track and Tune Program

BPA's Track and Tune program targets O&M energy savings in the industrial sector served by BPA's customer utilities. Eligible measures include efficiency improvements in the function, operation or control of equipment or systems. Track and Tune (1) pays incentives and provides technical assistance to industrial customers to scope potential O&M measures; (2) develops a performance tracking system that has the capacity to provide real-time performance feedback while also serving as an M&V platform to measure savings from O&M improvements; (3) performs an initial O&M "tune-up"; and (4) implement an O&M "action list" of hard-wired items that need to be repaired or installed to enable regular O&M tune-ups. The program then (5) provides an annual ex post "sustained savings" incentive per kWh of O&M energy savings documented by the performance tracking system over three to five year in duration.

Central to the program design, the performance tracking system typically consists of a software platform and sub-meters capable of collecting, consolidating and continuously tracking data on energy use and key energy driving factors in a facility, system, or process. The system calculates a baseline model of energy use based on variation of key energy driving factors, against which system performance and energy savings from O&M improvements can be monitored and measured (BPA 2009).[22] Energy savings are determined through cumulative sum of differences (CUSUM) analysis that calculates the ongoing difference between actual and baseline model

[22] See section 4.4.2 for details on baseline models.

energy consumption (Ibid.). The tracking system can be integrated with new or existing energy management systems, plant control systems, or turnkey online energy-tracking tools.

Performance tracking systems are not a unique attribute of the Track and Tune program. Energy management systems with similar characteristics have been incorporated, for example, in continuous building commissioning programs.[23] In these programs, incentives are provided to develop systems that provide direct feedback and optimized control options to building owners and tenants. In at least one program, incentives are also paid for energy savings from EEMs documented by the energy management system.[24] Whole facility baseline modeling in continuous building commissioning programs involves normalizing data based on standard energy driving factors such as weather and hours of operation and typically uses standard software platforms.[25] One of the challenges in using this approach in process-heavy industrial facilities is the diversity of possible independent variables driving energy use. Developing the methods, expertise and customer buy-in to implement custom performance tracking system for industrial operations thus represents a novel adaptation of the continuous commissioning DSM program model to the industrial sector.[26]

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[23] For example, BC Hydro's Continuous Optimization program for commercial buildings

[24] See New Jersey Clean Energy's Pay for Performance Commercial and Industrial Existing Buildings Program http://www.njcleanenergy.com/commercial-industrial/programs/pay-performance

[25] For example, ASHRAE 90.1 Appendix G compliant simulation software

[26] By the same token, the complexity of industrial energy use poses challenges for the confident determination of whole facility O&M energy savings which may be less than ten per cent of baseline energy use. BPA has attempted to address this challenge in three ways: (1) by requiring the reporting period for Track and Tune be three to five years to minimize the impact of short-term unexplained variations in baseline energy use, (2) building comprehensive baseline models that incorporate on average three energy driving factors to minimize unexplained variation in baseline energy use, and (3) implementing performance tracking systems at the sub-meter level at facilities where the load is large and consists of multiple processes – thus minimizing energy driving factors required to accurately model baseline usage and to increase the percentage of energy savings relative to baseline energy use.

Table 5. BPA Track and Tune Program Details

Eligible Applicants • Large industrial customers
Measure Eligibility • O&M improvements with an annual energy savings potential of at least 250,000 kWh/yr
Project Implementation • Scoping and initial O&M tune-up: qualified consultant or customer • Performance tracking system implementation: BPA MT&R team • O&M action list implementation and Sustained Savings: customer
Contract length • 3-5 years
Incentive • Scoping and O&M Tune-up funded up to 100% • O&M Action List item implementation funded up to 70% • $10,000-50,000 for tracking system set up and monitoring • An annual ¢/kWh sustained savings incentive is paid retroactively at the end of each year for persistent energy savings up to five years
M&V • CUSUM energy performance data from tracking system is assessed annually by BPA for energy savings

Source: BPA 2009; BPA, June 21st 2011; BPA, June 24th 2011; BPA, October 25th 2011

Track and Tune was introduced in November 2009 as part of BPA's Energy Management pilot within its Energy Smart Industrial portfolio. The Energy Smart Industrial portfolio was developed in response to aggressive energy efficiency targets set in the Northwest Power and Conservation Council's Sixth Power Plan.[27] The Energy Management Pilot represents BPA's effort to secure energy savings in previously untapped O&M improvements as well as increase overall development and performance of EEMs within the Energy Smart Industrial portfolio through improved energy management practices.

[27] The Bonneville Power Administration is a federal non-profit and self-funded agency based in the Pacific Northwest that markets wholesale electrical power from 31 federal hydro projects in the Columbia River Basin, a non-federal nuclear plant and other small non-federal power plants. BPA is tasked with meeting energy efficiency and conservation targets within its service area through the provision of DSM programming in accordance with the Northwest Power and Conservation Council's five year Power Plan. The Sixth Power Plan sets a target of reducing load growth by 85% with DSM by 2030.

To date, five industrial firms participating in Track and Tune have developed performance tracking systems, performed tune-ups and are now entering the sustained savings phase where they are eligible to receive annual incentives for ex post energy savings. Another twelve industrial firms are in the scoping phase of the program. Together, Track and Tune enabled O&M energy savings from the five facilities in the sustained savings phase is estimated to be 9.2 GWh per year at a cost of $326,659 to date with an estimated TRC benefit-cost ratio of 2.57 (BPA, June 24st 2011).[28] The subsectors participating in Track and Tune include food processing, pulp and paper, wood products, metal mining and high tech. The Track and Tune pilot ends in FY2011, but will be extended as a program offering in FY2012.

One of the unique attributes of the Track and Tune program is the link between the performance tracking system and performance incentives with the broader BPA energy management portfolio. BPA’s Energy Management pilot consists of three programs: (a) Energy Project Manager, (b) Track and Tune and (c) High Performance Energy Manager. The pilot was designed to encourage escalating participation in each program offering with the end goal of maximizing total Energy Smart Industrial projects and creating improved and sustained energy management practices. Energy Project Manager provides co-funding for dedicating staff to identify and develop capital and O&M improvements within customer facilities. Track and Tune develops a performance tracking system to monitor and measure O&M improvements and provides incentives to customers to sustain improved O&M practices. Track and Tune also creates an opportunity to identify capital-based EEMs in customer facilities through the detection of equipment or systems that are underperforming. High Performance Energy Manager leverages

[28] This figure represents scoping, performance tracking system development, action list implementation, tune-up and program administration. For the sustained savings period, these projects together will cost approximately $271,250 per year total for the duration of their contract assuming 9.2 GWh in actual annual energy savings (including program administration, performance tracking system maintenance and sustained savings incentive payments).

the performance tracking system and O&M focus in Track and Tune to incorporate a continuous improvement methodology into broader energy management practices. Similar to BC Hydro's Monitor, Targeting and Reporting (MT&R) program, industrial firms analyze data from performance tracking systems to identify period of exceptional performance or poor performance. The firms then identify operating practices that resulted in either outcome, periodically set energy saving targets based on exceptional performance periods and continuously track data for variances between actual performance and targeted performance (Wallace and Greenwald 2007). Unlike MT&R, BPA then provides ongoing incentives for measured energy savings from improved operations.[29]

Finally, given the noted tendency towards shorter contract duration in contemporary performance incentive programs, the Track and Tune program is unique in offering contracts for three to five years of sustained savings. Initially the period was five years, however it was reported that a number of BPA's utility customers expressed concern about the financial implications of the program extending between multiple rate setting periods (BPA, June 21st 2011). Accordingly, BPA set a minimum contract of three years. While longer-term contracts were problematic for some utilities, it was also reported that long-term data on customer operations acquired through M&V was viewed as a benefit (Ibid.). Notably, BPA reports the last year of sustained savings with a five-year measure life. According to BPA:

> The rationale for this savings claim is that by the five-year anniversary, the O&M practices that generate savings within the system of interest have cemented and are highly likely to be sustained. In the end, a Track and Tunes project yields a 10-year measure. This approach ultimately brings the Track and Tune measure on par with capital project measure lives as well as the measure lives identifies in the Sixth Power Plan (BPA 2009).

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[29] See section 1.5.3 for an explanation of MT&R

Whether or not the improved O&M practices indeed persist for five years beyond the end of the program remains to be seen and will certainly indicate the effectiveness of the program model to transform energy management practices within participating firms.

2.7 Conclusion

While the four generations of performance incentive program models evolved under different conditions, they are all the product of integrated resource planning and expanded jurisdictional energy efficiency requirements. From the origin of performance incentive programs at the dawn of integrated resource planning in the 1980s to the present, those objectives have required that program administrators find a cost-effective balance between ensuring sufficient participation such that planned energy savings are achieved and ensuring that energy savings are persistent through M&V.

As detailed in each generation of performance incentive program design, this balance has evolved over time in relation to changing conditions in each jurisdiction. The Standard Offer adopted contracts that resembled long-term energy purchase agreements, with PSE&G paying monthly incentives for measured energy savings up to the forecast avoided cost of supply. All EEMs required between five and fifteen years of continuous M&V. The Standard Offer largely targeted the program to energy efficiency service providers. As in the earlier generation of DSM bidding programs (as well as later Standard Performance Contract programs), ESCOs were considered essential to project development as they helped market the program, provided for or arranged for upfront financing, provided performance guarantees to host customers and brought turnkey technical capacity. Standard Performance Contract programs, including Existing Facilities and PSP-T Project Incentives, reduced incentive payments but shifted the bulk of the incentive to an upfront payment to address participant capital constraints. They also streamlined

M&V, to varying degree, so that it is more cost-effective and less burdensome to participants. In the case of Exiting Facilities, the scope and cost of M&V is matched to the risk of the particular EEM with some measures requiring only engineering analysis and verification. PSP-T Project Incentives require up to one year of continuous M&V for most projects. In Both Existing Facilities and PSP-T Project Incentives, the utilities reserve the option to prorate the incentive balance or require reimbursement following post-implementation M&V. Finally, Track and Tune provides incentives and assistance to industrial customers to implement energy performance tracking systems and longer-term incentives for measured O&M energy savings. The tracking systems provide energy performance feedback to customers to enable O&M improvements and broader energy management practices, while also serving as an M&V platform for BPA.

The unique balance of program attributes in each program model detailed in this chapter will be assessed in Chapter 6 in relation to economic, technological and organizational conditions identified as risk factors to DSM development and performance in the BC large industrial sector. The assessment will indicate the potential effectiveness of the program models in the BC large industrial sector. As a prelude to developing the criteria to assess the performance incentive program models, the following chapter will back away from the individual performance incentive programs in order to broaden the reader's understanding of the structure of energy efficiency incentive programs in general and their relative effectiveness in the industrial sector.

3 Review of Energy Efficiency Incentives

3.1 Introduction

As background to the assessment of performance incentive programs, this chapter presents a review of the literature on energy efficiency incentives. The objectives of energy efficiency incentive programs are first considered, specifically contrasting resource acquisition and market transformation. A typology of energy efficiency measures (retrofit, replacement, O&M) and incentives (prescriptive, custom, performance) is then detailed and program types assessed with respect to the industrial sector. It is argued that, of all the incentive program types, performance incentives are best suited to the industrial sector because of the broad range of energy savings potential they can target and the certainty of energy savings they provide. The chapter concludes with a basic framework of program considerations that emerge from resource acquisition-based energy efficiency incentive programs. The first consideration is DSM development, or how programs maximize cost-effective participation while limiting free riders (participants who would have implemented the incented device or systems in the absence of incentives). The second consideration is DSM performance, or how programs maximize and ensure the persistence of energy savings. The latter framework will be used in Chapter 4 to inform the consideration of industrial DSM risk and risk management options.

3.2 Rationale for Energy Efficiency Incentives

It is commonly argued that EEMs have not reached their maximum market potential if consumers are making decisions on levelized cost alone (Howarth and Anderson 1993; Golove and Eto 1996; Brown 2001). In the industrial sector the reasons cited for underinvestment in energy efficiency include capital constraints, risk aversion, organizational and operational dynamics, and lack of energy management practices (Ross 1990; DaCanio 1993; Golove and Eto 1996; Brown 2001; Elliot 2008; Russell 2009).[30] As such, energy efficiency requires varying degrees of intervention to ensure that it reaches a socially optimal level of cost-effective investment. Subsidies, or incentives, for energy efficiency are one form of intervention used by DSM administrators to incent energy consumers to adopt high efficiency technologies and practices (Nadel and Geller 1996).

3.3 Energy Efficiency Incentive Program Objectives

A primary policy objective for many energy efficiency incentive programs is influencing a predictable reduction in energy consumption to meet system planning requirements (so called "resource acquisition") (Prahl and Schlegal 1994; Nadel and Geller 1996; Rufo 2008).[31] Resource acquisition incentive programs attempt to maximize customer participation and reliable cost-effective energy savings, while minimizing free riders.[32] DSM administrators focus on EEMs (technology or practices) that have moderate diffusion in the market to ensure there is sufficient acceptance and availability to enable an incentive to be effective (Ibid.) At the same time, DSM administrators are careful that energy performance eligibility levels for EEMs are sufficiently high to maximize energy savings and minimize free riders (Prahl and Schlegal 1994; Nadel and Geller 1996). Incentives must result in directly measurable energy savings to provide DSM administrators with certainty that resource requirements have been achieved (e.g. hard-wired measures qualify as resource acquisition but education programs do not).

[30]Barriers to industrial investment in energy efficiency are reviewed in section 4.3.1.

[31] In some cases, also a predicable reduction of greenhouse gas emissions.

[32] Free riders are detailed in section 4.3.2.

Energy efficiency incentives can also be designed to support "market transformation" policy objectives. Market transformation seeks to achieve long-term and comprehensive energy savings by increasing the awareness, acceptance, availability, affordability and market segment accessibility of high efficiency technologies, practices and related services (NRCan 2010). Market transformation initiatives frequently target a broad range of market actors (e.g. customers, trade allies and manufactures) and involve a concerted effort between DSM administrators and regulators (Nadel and Geller 1996; Nadel 1999). For example, utilities provide an incentive to customers for a particular high efficiency device that is emerging or has low penetration in order to increase market share and public acceptance. Once the device achieves a high level of market share, a regulation is introduced stipulating such devices must meet a minimum energy performance standard in order to be manufactured, sold or leased in that jurisdiction.[33] The regulation serves to backstop the increased market share made initially through voluntary measures and eventually make the market share universal (Pape-Salmon and Ross 2010). In addition to technologies and practices, market transformation also targets services. For example, incentive programs will include energy efficiency service providers as eligible participants to increase customer familiarity and confidence in energy services and assist in building industry capacity (e.g. ESCOs or otherwise) (Eto et al. 1998). Finally, DSM administrators place less emphasis on minimizing free riders in market transformation-based incentive programs, at least initially, as the objective of increasing the market share of a particular EEM is viewed as the primary objective (e.g. to build legitimacy for regulation) (Prahl and Schlegal 1994; Pape-Salmon 2011).

[33] See for example, British Columbia's *Energy Efficiency Act*, which stipulates a person can not manufacture, offer for sale, sell, lease or otherwise dispose of regulated energy devices or systems that don't meet a prescribed efficiency standard.

Resource acquisition and market transformation objectives have different implications for resource planning. Both Prahl and Schlegal (1994) and Nadel and Geller (1996) observe in their assessment of utility DSM that market transformation initiatives require longer-term commitments to achieve energy savings given the broad coordination required. From a program perspective, incentives are only one part of market transformation and may not have an immediate and predictable result compared to resource acquisition programs (Prahl and Schlegal 1994). That said, the magnitude of energy saving potential is often greater than resource acquisition initiatives due to the possibility of participation approaching 100% following market transformation (Nadel and Geller 1996). Programs with resource acquisition objectives, on the other hand, put a greater emphasis on energy savings achieved in shorter-term planning time frames, which may or may not have lasting transformative impacts on a market as a whole. While both strategies are pursued by DSM administrators, often in conjunction with each other, Prahl and Schlegal (1994) note that utilities pursue a resource acquisition strategy under conditions in which highly controllable impacts are required. This study focuses on industrial energy efficiency incentive programs that have a primary objective of resource acquisition in view of the expectation that BC Hydro reduce at least 66 per cent of new electricity demand with DSM by 2020 in the *Clean Energy Act*.

3.4 Energy Efficiency Measure Typology

To provide context for a consideration of industrial energy efficiency incentive program design, the following section reviews energy savings potential in the industrial sector and corresponding EEMs. In his study of industrial energy management, Russell (2008) argues that, notwithstanding energy losses due to the laws of physics, industrial facilities waste energy for three reasons (1) degradation of production assets over time, (2) the emergence of more efficient technologies and practices and (3) ineffective operations and maintenance (O&M) procedures. Russell notes energy waste by an industrial facility reflects a temporal continuum of decisions from the most basic choices about the design of process systems to annual procedures for procurement, operations and maintenance and finally, the daily and hourly decisions of equipment operators. Fundamental design decisions are long-term commitments to a particular "vintage" of technology (Ibid.). For example, large fixed capital assets such as boilers represent substantial financial investment and will operate for many years before being retired and replaced with more efficient models. Smaller components of process systems such as motors, pumps and fans are relatively easy to upgrade, however the design of the system is not easy to modify without disruption to production.[34] Ultimately, whether an industrial system has been poorly configured or represents best available practices at the time, production assets degrade with use over time, the cost of energy increases and the benchmark for most efficient technology, systems and practices continues to rise (Ibid.). All of these factors account for energy waste in industrial facilities.

While energy use in the industrial sector is a function of technology, it also has a decidedly behavioural component. In its study, *Tracking Industrial Energy Efficiency and C02 Emissions*, the International Energy Agency (IEA) notes, organizational dynamics and the inertia of traditional operating practices can create obstacles to optimizing and maintaining energy systems, identifying systemic energy saving opportunities and implementing energy saving measures (IEA 2007). The IEA further notes industrial production is a dynamic process with a constantly changing output and corresponding variation in energy load. Production changes

[34] Operational and capital investment cycle constraints on energy efficiency improvement are discussed in section 4.3.1.

overtime can degrade the energy efficiency of a system if operational procedures or systems to identify and adapt energy supply and production output are not in place (Ibid.).

Given the nature of energy saving potential in the industrial sector, there are two primary categories of EEMs targeted by industrial energy efficiency incentives: capital and O&M (detailed in Table 6). Capital EEMs include equipment efficiency improvements made in response to degradation of capital stock over time, emergence of more efficient technologies, as well as new construction (U.S. EPA 2008). Capital measures are further split into retrofit, replacement and new construction EEMs. Each EEM type has different implications for how energy savings are determined and the level of incentive provided.

Table 6. Energy Efficiency Measure Typology

EEM Type	Definition	Example	Impact Measurement	Measure Cost
Capital Replacement (Failure or Natural)	Customer is in the market for a new piece of equipment because their existing equipment has worn out or otherwise needs replacing. Incentive encourages customer to purchase and install efficient instead of standard equipment.	The utility provides a financial incentive that encourages the customer to purchase a more expensive, but more efficient and longer-lasting CFL bulb instead of an incandescent bulb.	Projected consumption of standard device **minus** consumption of efficient device **Retrofit.**	Cost of efficient device **minus** cost of standard device *(Incremental).*
Capital Retrofit (Early replacement)	Customer's existing equipment is working with several years of useful life remaining. Incentive encourages customer to replace and dispose of old equipment with a	The utility provides a financial incentive toward the purchase of a new, more efficient refrigerator upon the removal of an older, but still working refrigerator.	Projected consumption of old device **minus** consumption of efficient device.	Cost of efficient device **plus** installation costs *(Full) or* Cost of efficient device **minus** cost of standard device **plus** remaining present value of old device

	new, more efficient one.			*(Incremental).*
Operations and Maintenance	Customer's existing O&M procedures are not optimized. Incentive encourages customer to adopt sustained operational improvements.	The utility provides financial incentives to adopt sustained operational improvements.	Projected consumption under old O&M procedures **minus** consumption under new O&M procedures.	Cost of old O&M procedures **minus cost of** optimized O&M procedures (Incremental) (U.S DOE 2010).

Source: Adapted from U.S. Environmental Protection Agency, National Action Plan for Energy, *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*, 2008.

3.4.1 Retrofit Measures

Retrofit measures incent customers to upgrade old equipment and systems for higher efficiency models or configurations. For example, a customer would receive an incentive to retrofit a compressed air system with premium efficiency motor. The energy savings are determined by subtracting the actual energy consumption from the efficient device from the estimated energy consumption of the old device or system.[35] As retrofitting often means the customer is forfeiting the remaining present value of the less efficient device or system, incentive levels can range up to full cost of the new measure and installation in order to effectively move the market (Ibid.).

3.4.2 Replacement and New Construction Measures

Replacement and new construction EEMs target so called "lost opportunity" situations, where there is a time sensitive opportunity to incent a customer to improve efficiency for the incremental cost difference of the average and high efficiency equipment (Eto et al. 1998). An example would be the replacement of a boiler at the end of its useful life or a plant capacity expansion. Energy savings are determined by subtracting the prospective energy consumption of

[35] Note, a detailed discussion of methods for determining energy savings is included in section 4.4.2

a standard device or system minus the energy consumption of the efficient device or system. As lost opportunity incentives are based on incremental cost difference, they are typically more cost-effective than retrofit programs (Nadel and Geller 1996). Note, as the focus of this study is on energy efficiency programs which target existing facilities, lost opportunity EEMs will be considered exclusively in terms of replacement.

3.4.3 O&M Measures

According to the U.S. Department of Energy (2010), O&M measures include optimization of schedules, procedures, system controls or equipment function. They also include routine, predictive and preventive maintenance of equipment and systems (U.S. DOE 2010). As an example, with boilers, an operational measure is ongoing optimization of firing rate with respect to load schedules (Ibid.). A system level operational measure might include changing assembly line sequencing to reduce the need for compressed air. With compressed air systems, maintenance measures include daily, monthly and annual upkeep as detailed (for example) in the U.S. DOE's *Operations & Maintenance Best Practices guide* below.

Table 7. Air Compressor Maintenance Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Compressor use/sequencing	Turn off/sequence unnecessary compressors	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Leakage assessment	Look for and report any system leakages	X			
Compressor operation	Monitor operation for run time and temperature variance from trended norms	X			
Dryers	Dryers should be observed for proper function	X			
Compressor ventilation	Make sure proper ventilation is available for compressor and inlet	X			

Compressor lubricant	Note level, color, and pressure. Compare with trended values.	X			
Condensate drain	Drain condensate from tank, legs, and/or traps	X			
Operating temperature	Verify operating temperature is per manufacturer specification	X			
Pressure relief valves	Verify all pressure relief valves are functioning properly		X		
Check belt tension	Check belt tension and alignment for proper settings		X		
Intake filter pads	Clean or replace intake filter pads as necessary		X		
Air-consuming device check	All air-consuming devices need to be inspected on a regular basis for leakage.		X		
Drain traps	Clean out debris and check operation		X		
Motor bearings	Lubricate motor bearings to manufacturer's specification			X	
System oil	Depending on use and compressor size, develop periodic oil sampling to monitor moisture, particulate levels, and other contamination. Replace oil as required.			X	
Couplings	Inspect all couplings for proper function and alignment				X
Shaft seals	Check all seals for leakage or wear				X
Air line filters	Replace particulate and lubricant removal elements when pressure drop exceeds 2-3 psi				X
Check mountings	Check and secure all compressor mountings				X

Source U.S. DOE, *Federal Energy Management Program, Operations & Maintenance Best Practices*, 2010.

As with replacement measures, O&M energy savings are incremental. Energy savings are determined by projected consumption under old O&M procedures minus actual consumption under new O&M procedures. Likewise costs are determined by subtracting old O&M procedures minus cost of optimized O&M procedures. The appeal of exploiting O&M energy savings potential reflects its lower overall costs relative to capital measures (Ibid.). That said, O&M savings require ongoing actions and monitoring to remain persistent and prevent backsliding.

Note, energy management programs also focus on improving operational efficiency, but typically do so through the provision of enabling tools, such as technology and expertise, to assist customers in broadly planning and tracking energy use. As such, energy management programs do not typically fall under the purview of resource acquisition programs that offer per kWh incentives, as the savings are not clearly attributed to specific tools. That said, O&M incentives form the foundation of BPA's energy management portfolio (Energy Smart Industrial) as discussed in section 2.6. While out of the scope of this study, the potential linkage between resource acquisition incentive programs and energy management initiatives is a critical area for future research.

3.5 Consumer Energy Efficiency Incentive Typology

The following section provides a general description of resource acquisition-based consumer energy efficiency incentive program types. The efficacy of the program types to the industrial sector will be considered in the concluding section of this chapter. DSM administrators have employed energy efficiency incentive programs targeting consumers since the inception of DSM in the late 1970s. Over the course of the 1980s and 1990s, DSM administrators developed a number of energy efficiency incentive approaches to secure cost-effective energy savings in different markets (Eto 1996). All of these basic program types, prescriptive incentive programs, custom incentive programs and performance incentive programs, are still used today in varying forms. Prescriptive incentive programs offer a standard subsidy for pre-specified high efficiency technologies and are utilized in all sectors. Custom incentive programs target broader, customer-specific energy efficiency measures in the large non-residential sectors (Nadel and Geller 1996).

Both prescriptive and custom incentive programs establish energy savings based on ex ante estimates (CBP 2004). Performance incentive programs are similar to custom incentives, though they require site-based, ex post measurement of energy savings. They also frequently include energy efficiency service providers as eligible participants (Nadel and Geller 1996; CBP 2004). Table 8 details the differences in measures and sectors targeted, incentives provided, eligible participants, program format and M&V requirements.

Table 8. Consumer Energy Efficiency Incentive Typology

	Prescriptive Incentives	Custom Incentive	Performance Incentives
Objectives	Acquire energy savings	Acquire energy savings	Acquire energy savings; transfer performance risk away from rate payers; transform energy services market
Measures Targeted	Pre-specified technologies	Broad technologies	Broad technologies and practices
Incentive	$/technology	$/kWh ex ante	$/kWh ex post
Target Sector	All sectors	Commercial, institutional, industrial	Commercial, institutional, industrial
Participants	Customers	Customers	Customers, energy service providers
Format	Standard offer $/technology	Standard offer $/kWh saved	Bidding or standard offer $/kWh saved
M&V	Energy savings stipulated	Impact evaluation	Site-based

3.5.1 Prescriptive incentive programs

Prescriptive incentive programs provide a fixed subsidy for implementation of specific high efficiency technology (e.g. a rebate for purchasing a premium motor). The programs focus on technologies that are relatively mature, with documented operating efficiencies and operating profiles, for example high efficiency lighting, motors, appliances. Energy savings are typically stipulated based on standard wattage tables and operating hours (Schiller 2000). Prescriptive incentives thus target measures where there is sufficient homogeneity in usage to provide confidence in energy savings estimates.

3.5.2 Custom incentive programs

Custom incentive programs target broad, participant-identified measures. Broader eligibility serves to accommodate comprehensive and sector-specific measures in the large non-residential sectors (CBP 2004; Chittum et al. 2009). As DSM administrators do not prequalify the measures, technical engineering review of the proposed EEMs is often part of the incentive approval process. Unlike prescriptive incentives, custom incentives pay a rate per kWh of savings. Incentives are either set at one level for all projects or price differentiated to promote priority EEMs and limit free riders (CBP 2004). Incentive levels vary from incremental to full costs depending on program objectives, market conditions and resource availability. Incentives are typically determined based on ex ante engineering calculations of energy savings (Ibid.). Measures are installed by customers or trade allies of the utilities, for example BC Hydro's Power Smart Alliance. DSM administrators typically assess the efficacy of the program through impact evaluations using a sample-based methodology to extrapolate ex post energy savings at the program level (Ibid).

3.5.3 Performance incentive programs

Like custom incentive programs, performance incentive programs target broad, participant-identified measures in the large non-residential sectors (e.g. process system upgrades), including O&M improvements. As detailed in chapter 2, performance incentive programs have adopted a number of formats over the years, including DSM bidding, standard offer, standard performance contract and data-driven pay for performance models. With the exception of DSM bidding programs, all of the latter program models pay a posted rate per kWh of energy savings. Like custom incentive programs, performance incentive rates can be price differentiated to promote priority EEMs and limit free riders. As well, incentive levels vary from incremental to full costs based on program objectives, market conditions and resource availability. Unlike custom incentive programs, performance incentives are based on measured energy savings over time, though some portion of the incentive may be paid upfront based on engineering calculations (Ibid.). In many performance incentive programs, for example NYSERDA's Existing Facilities or BC Hydro's PSP-T Project Incentives, participants guarantee energy savings in performance-based contracts that stipulate awarded incentive funds may be prorated or reimbursed if the estimated energy savings are not achieved. In other programs, incentives are paid exclusively for ex post energy savings, for example PSE&G's Standard Offer or BPA's Track and Tune. Notably, it is this latter program attribute that allows for performance incentives to include O&M measures which require continuous M&V to demonstrate persistence (BPA, June 21st 2011). Up to two years or more of M&V is not uncommon for performance incentive programs. As noted, DSM program administrators have frequently included energy efficient service providers as eligible participants in performance incentive programs. The inclusion of third-party participants represents a strategy to shift project development and performance risk away from ratepayers and stimulate the energy service sector as a potential exit strategy for performance incentive programs (Schiller et al. 2000; Goldman and Kito 1994).

3.6 Energy Efficiency Incentive Programs in the Industrial Sector

The primary goal of the resource acquisition-based energy efficiency incentive program types considered thus far is to maximize customer participation and reliable cost-effective energy savings, while minimizing free riders. In the final section of this chapter, this study will assess the efficacy of the program types to achieve these goals in the industrial sector.

In their survey of Utility DSM, Nadel and Geller (1996) note that prescriptive incentives tend to have high participation rates because they are easy for consumers to understand and use. Nadel and Geller, and Eto et al. (1998) further note that prescriptive incentives are particularly effective at capturing time-dependent opportunities such as replacement, which are typically more cost-effective than retrofit measures. Prahl and Schlegal (1994) argue that resource acquisition-based prescriptive incentive programs have worked best with relatively mature technologies as customer response and usage patterns are understood well enough to result in predictable energy savings. While focusing on prequalified technologies with predicable energy savings characteristics requires DSM administrators to deploy fewer resources towards M&V to ensure energy savings are real and persistent, prescriptive incentives have limited efficacy in the industrial sector. As Nadel and Geller (1996) note, prescriptive incentives are not effective at promoting system-based energy efficiency improvements that present a large portion of energy savings potential in the industrial sector. Chittum et al. (2009) observe that prescriptive programs are ineffective at achieving energy savings outside of the scope of their specific technology. Prescriptive incentives are thus effective at incenting cross-cutting technologies (e.g. high efficiency motors) and facility-based efficiency improvements (e.g. lighting) in the industrial sector, but are not applicable to process system improvements that require a flexible and customizable approach (Chittum et al. 2009).

Given the focus of resource acquisition-based prescriptive incentives on relatively mature technologies, these programs have to contend with a substantial risk of free riders – particularly if the minimum energy performance requirement for eligible devices is too close to average device efficiency (Nadel and Geller 1996; Prahl and Schlegal 1994). In all sectors, the most effective prescriptive incentive programs set minimum energy performance requirements just low enough to maximize net participation, and thus net energy savings (Ibid.).[36]

Unlike prescriptive incentives, custom and performance incentives are designed for large, complex EEMs and are thus effective at tapping deeper energy savings in the industrial sector. In its review of non-residential, large comprehensive incentive programs, The California Best Practices Project Advisory Committee (2004) notes that custom and performance incentives are designed to accommodate comprehensive measures with a wide range of efficiency and operational characteristics. These EEMs, whether they be process systems or O&M improvements (exclusively in the case of performance incentives), are industry-specific and entail relatively large energy savings potential (Chittum et al. 2009). Given the heterogeneous nature of custom EEMs and the considerable resources at stake in these programs (both in terms of energy savings and financial incentives) custom and performance incentives have made reducing uncertainty in energy savings a key program design component. As noted, custom incentive programs opt to reduce uncertainly in energy savings *estimates* by requiring a technical engineering review of the EEM prior to approval. Performance incentives reduce uncertainty in *actual* energy savings by requiring measurement of the EEM following implementation to true up initial engineering estimates. The two program strategies have implications for program cost, program participation and risk allocation.

[36] Nadel and Geller (1996) define net savings as " the difference in savings between a group of programme participants and an otherwise similar control of programme non-participants." Net participants are thus those participants who would not have implemented an EEM without an incentive.

Custom incentives, in effect, streamline the participation process and program costs by limiting M&V to ex ante calculations, but do so at the cost of reducing the certainty of energy savings and transferring the risk of underperformance to ratepayers. Performance incentives on the other hand, may limit program participation and increase program cost by requiring ex post M&V, but do so at the benefit of increasing the certainty of energy savings and transferring performance risk to program participants. As Goldman et al. (1995) observe in their Evaluation of PSE&G's Standard Offer Program, "Standard Offer and DSM bidding programs effectively shift performance risk to DSM developers and way from ratepayers, but the cost premium can be significant compared to customized rebate programs…" They further note, "with comparable financial incentives, customized rebate programs are likely to achieve greater market penetration than the other two approaches although the persistence of savings is more uncertain." In performance incentive programs where energy efficiency service providers are eligible participants, they have played a role in mitigating that additional burden placed on customers by offering turn-key project development and assuming some degree of performance risk (Nadel and Geller 1996).

Minimizing free riders is more challenging in custom and performance incentive programs than prescriptive programs due to the level of end-user sophistication in the large non-residential sectors (CBP 2004). While industrial firms, for example, implement a range of custom EEMs in spite of program influence, there is also evidence that there are numerous cost-effective EEM opportunities that they do not adopt without program support (Ibid.). Another challenge for custom and performance incentive programs in the industrial sector is that opportunities for significant efficiency improvement are based on equipment replacement (Elliot et al. 2008). For programs offering incentives beyond incremental costs in this context, there is a heightened risk of free riders. Free ridership in the industrial sector, along with program management options employed by DSM administrators to effectively maximize net participation, are discussed in detail in section 4.4.2 and 4.4.3.

This study argues that of all the program types considered, performance incentive program types are best suited to the large industrial sector. For DSM administrators faced with expanded jurisdictional energy efficiency requirements and pursuing resource acquisition objectives, performance incentive programs target the broadest range of energy savings potential (i.e. process systems and O&M), provide the greatest certainty of energy savings (given continuous M&V) and transfer the risk of EEM underperformance away from ratepayers.

3.7 Conclusion: DSM Development and Performance

Two primary axes of program considerations emerge from an assessment of resource acquisition-based energy efficiency incentive programs. The first is DSM development, or how programs maximize cost-effective net participation. The second is DSM performance, or how programs maximize and ensure the persistence of energy savings. Each program type has employed a different strategy with respect to DSM development and performance depending on the measures and sectors targeted. Prescriptive incentive programs focus on cross-cutting technologies that have common usage patterns and moderate market diffusion in order to generate predictable participation and performance (with minimal M&V costs). However, prescriptive incentive programs are not effective at promoting system-based energy efficiency improvements that present a large portion of energy savings potential in the industrial sector. Custom and performance incentive programs are designed for large, complex EEMs and are thus effective at tapping deeper energy savings in the industrial sector. Both program types attempt to maximize DSM development by providing financial incentives and resources to minimize barriers to investment in energy efficiency. Custom incentive programs maximize DSM development further by limiting M&V to ex ante calculations, thus streamlining the participation process and minimizing program costs. Custom incentives do so, however, at the cost of reducing DSM performance, i.e. reducing the certainty of energy savings and transferring the risk of underperformance to ratepayers. Performance incentives on the other hand, may limit program participation and increase program costs by requiring ex post M&V, but do so at the benefit of increasing the certainty of energy savings and transferring performance risk to program participants. Likewise, as noted, performance incentive programs can target a broader range of energy savings potential given their continuous M&V. The following chapter will apply the DSM development and performance framework to consider economic, technological and organizational conditions that pose a risk to DSM in the BC large industrial sector.

4 Industrial DSM Risk Framework

4.1 Introduction

This chapter develops the analytical framework used to assess the performance incentive programs. The concept of energy savings reliability is first reviewed with respect to resource acquisition objectives. DSM risk, or uncertainties that impact the cost-effective acquisition of planned energy savings, is then defined. *ISO 31000 - Risk Management Principles and Guidelines* is then considered and its framework for identifying risk factors, events and impacts, and prescribing related risk management options is adopted. Next, Goldman and Kito's (1995) DSM risk framework detailing DSM development and performance risks is presented. Goldman and Kito's framework is applied to the large industrial sector and DSM risk factors and risk management options are identified. Next, BC industrial DSM risk is considered and key development and performance risk factors are identified. Together, the industrial DSM risk factors and risk management options are used in Chapter 5 (Methods) to develop the performance incentive program assessment criteria.

4.2 Reliability and Risk

DSM resource acquisition policy objectives reflect a paradigm that EEMs, like supply-side resources, are a system resource capable of reliably meeting energy planning requirements (Prahl and Schlegel 1994; Nadel and Geller 1996; Rufo et al. 2008). Viewed as a system resource, DSM is subject to the same general considerations as supply resources. DSM, or measures to influence the energy usage of consumers, is thus planned, developed and measured to ensure a reliable reduction in energy consumption and/or peak load (Gelling 1985; Prahl and Schlegel 1994). However, while DSM and supply resources share similar system-level considerations, the implications for how utilities plan, develop and ensure the performance of EEMs are fundamentally different. Unlike supply resources, energy savings from resource acquisition-based EEMs are an aggregate resource that reside in the hands of consumers and are obtained by measures that effectively influence consumers to reduce energy consumption (Harrington 2003). DSM thus presents a bottom-up resource that requires program planners and administrators to consider the economic, behavioural and technological constraints of the sector in which they seek to implement EEMs. Together, these constraints represent DSM development and performance risk factors that, if not managed effectively in program design, can reduce the reliability of planned energy savings from DSM incentive programs. This chapter argues that in the BC large industrial sector, and characteristic of large industrial sectors in general, these DSM risk factors include commodity market-driven financial instability, capital constraints, lack of internal resources, variable load energy saving potential, and a lack of energy performance feedback at operational and corporate levels.

4.3 DSM Risk

ISO standard 31000- Risk management Principles and Guidelines was published in 2009 to provide a standardized framework for organizations to assess and manage risk. The standard conceptualizes risk as the "effect of uncertainty on objectives" (ISO 2009). Effect is defined as a "deviation from the expected" (Ibid.). The standard advises that risk be broken down intro three elements in order to develop management options: (1) risk sources (factors), (2) risk event and (3) potential risk consequences (Ibid.). For those risks that can't be avoided, risk management options are either a function of changing the likelihood of the risk event by addressing the cause or changing the potential consequences of the risk (i.e. mitigating negative impacts) (Ibid.). Figure 1 illustrates the breakdown of generic risk components and management strategies using a common “bow-tie” risk diagram. The IS0 31000 risk framework is useful for assessing the underlining conditions that affect DSM, the implications of those conditions and the strategies used to minimize DSM risk.

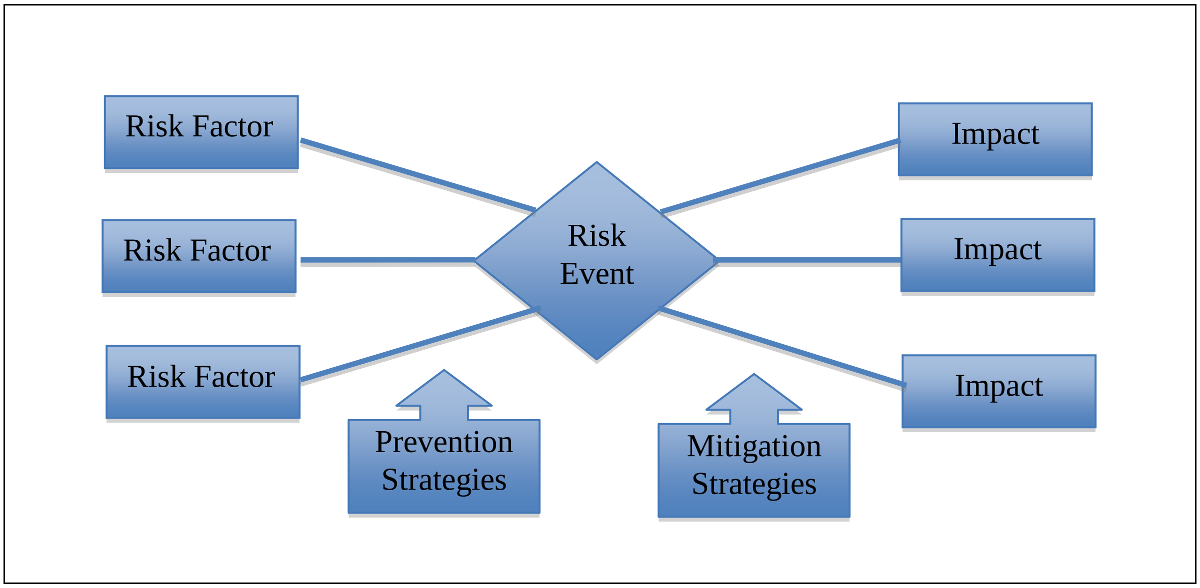

Figure 1. Risk Identification and Management Options

The objective of DSM resource acquisition programs is to cost-effectively and reliably obtain planned energy savings. Following from the ISO 31000 definition, DSM risk can therefore be defined as uncertainties that affect the cost-effective acquisition of planned energy savings from DSM measures. This study argues that aggressive DSM requirements expose utilities to a greater level of DSM risk by requiring a greater level of programming efforts. DSM risk is primarily a subset of financial risk as the impact of not achieving planned energy savings is the diminished cost-effectiveness of achieved energy savings and insufficient resources to meet forecast load (BC Hydro 2009). The latter necessitates the development of new DSM programs or purchasing/developing contingency supply-side resources, ultimately at the ratepayer’s expense

(Ibid.). DSM risk also has implications for a utility's reputation, as the failure of EEMs to develop or perform as expected undermines the utility's credibility (Ibid.).

Goldman and Kito (1995) developed a risk framework to assess risk allocation and risk mitigation strategies in DSM bidding programs and large non-residential custom incentive programs. The framework, which is broadly applicable to performance incentive programs, breaks DSM risk into three categories: development risk, performance risk and demand risk (Goldman and Kito 1995).[37] Development risk represents the project ramp-up phase and is the risk that planned energy savings do not materialize due to (1) low customer response to DSM program incentives or (2) EEM are not implemented successfully in customer facilities or in accordance with schedules (Ibid.) Performance risk represents the operational phase and is the risk that planned energy savings do not persist over the effective measure life due to energy savings deterioration (Ibid.). Demand risk is the risk that the utility's forecasted need for energy savings may diminish over the economic lifetime due to diminished demand (inaccurate load forecasts) or diminished cost of supply side alternatives (Ibid.). This study focuses on development and performance risk, as demand risk factors are largely exogenous to performance incentive programs. Table 10 adapts the Goldman and Kito DSM risk framework to the industrial sector, while further fleshing out development and performance risks, contributing factors and potential impacts as reviewed in sections 4.3 and 4.4.

[37] BC Hydro refers to DSM risk in its draft Integrated Resource Plan as "deliverability risk." In terms of DSM programs, BC Hydro notes deliverability risk is a function of (1) participation rates (2) savings per participant.

Table 9. Industrial DSM Risk Framework Adapted from Goldman and Kito (1995)

DSM Risk Type	Risk Factors	Risk Events	Risk Impacts
Development Risk	Constraints to investment in energy efficiency as result of volatile market conditions; customer who would implement EEMs in the absence of incentives will take advantage of incentives	Industrial customers do not respond to utility DSM program incentives due to low priority of EEMs or lack of access to capital; EEMs are not developed successfully or in accordance with schedules; excessive free riders	Lower participation rates; utilities will be required to adjust energy planning, either developing new DSM programs or purchasing/developing additional supply-side resources
Performance Risk	Large industrial sector financial instability; Variable load, process-based energy savings potential	Projected energy savings do not persist over the effective measure life of EEMs due to one or some combination of the following: (a) deficiency in technology or practice; (b) lack of maintenance or optimization of energy system improvements; (c) M&V methods insufficient to accurately document energy savings; (d) host customer substantially changes operations or goes bankrupt	Less savings per participant; diminished cost-effectiveness of DSM resource; stranded investment

Source: Adapted from Goldman and Kito, A review of DSM Bidding Programs (1995)

4.4 Development Risk

As noted, Goldman and Kito (1995) cite two components to development risk: (1) the risk of low customer response to DSM program incentives and (2) EEM are not implemented successfully in customer facilities or in accordance with schedules. In view of the primacy of net energy savings in resource acquisition programs, the first component of development risk can be modified to the risk of low *net* customer response to DSM program incentives. Development risk is thus, in part, the risk that incentives will not adequately incent sufficient customers to participate who would not have otherwise installed the EEMs. Free riders notwithstanding, both development risk components have been associated with general barriers to investment in energy efficiency – the primary rationale for energy efficiency incentive program intervention (Golove and Eto 1996; U.S. EPA 2006). What follows is a review of industrial constraints to investment in energy efficiency and free ridership, both risk factors to DSM development. The section concludes with a survey of DSM development risk management options.

4.4.1 Constraints to Industrial Investment in Energy Efficiency

Despite the substantial potential for cost-effective energy savings opportunities in the industrial sector, many industrial firms are disinclined to pursue EEMs. This reluctance is reflected in the tendency of firms to require short payback periods and rates of return from EEM investments in excess of standard market rates for borrowing or saving (Ross 1990; DaCanio 1993; Brown 2001; Russell 2009; Bunse 2010). The difference between economic energy efficiency potential and actual investment is often referred to as the energy efficiency "gap" in the energy policy literature. Extensive research attributes the energy efficiency gap to market barriers, or market failures in neo classical terms, preventing energy efficiency from reaching its socially optimal level (Howarth and Anderson 1993; Jaffe and Stavins 1994; Golove and Eto 1996; Brown 2001).[38] The mitigation of barriers to bring private uptake of EEMs closer to a socially optimal level, or maximum market potential if consumers were making decisions based on market rates for borrowing or saving, is one of the primary rationales for DSM market intervention.

[38] Market barriers and market failures, in neo-classical economic terms, are conditions which respectively slow or prevent the market from reaching an economically efficient allocation of resources (Arrow 1969). While there is debate as to what degree market failures comprise market barriers and vice versa, in terms of energy efficiency, market failures and barriers can both be understood as market distortions that lead to the systematic underinvestment in cost-effective EEMs (Golove and Eto 1996).

At a high level, requiring short payback periods and applying high rates of return to energy efficiency investment reflects a risk-based corporate assessment of where capital and labour should be put to their highest and best use (Russell 2009). This assessment is made in the context of a firm's market conditions, business priorities and organizational dynamics (Ibid.). Factors such as the stability of markets, increasing or decreasing market share of products, capital access, existing debt load, prospective energy prices, operational cycles and the perceived reliability of new EEMs all influence how fast and how great a return on energy efficiency investments is deemed necessary (Russell 2009; Elliot et al. 2008). However, economic considerations are not the only factors influencing investment criteria for EEMs. A firm's organizational dynamics shape the decision making process itself by determining who is responsible and accountable for energy related decisions. This also shapes the relative strategic importance of energy related decisions, and the internal risks and rewards that apply to individuals pursuing EEMs (Ross 1990; DaCanio 1993; Russell 2009).

What follows is a brief review of the literature on the above barriers that have limited energy efficiency investment in the industrial sector and thus pose a risk to DSM project development. Well documented, and by no means mutually exclusive, barriers to energy efficiency investment in the industrial sector include:

Capital constraints

Despite the potential for profitable financial returns from reduced operating costs, industrial firms are often unwilling or unable to invest capital or utilize their credit capacity to finance EEMs. There a number of factors which explain this reluctance:

- *Upfront costs (constrained capital access)*: The financing structure for EEMs often involves an investment of upfront capital or equity followed by a future cash flow based on avoided energy costs. For firms who are on the low end of a business cycle, experiencing losses and faced with low capacity utilization, capital may be unavailable or limited to core operations (Ross 1990; Elliot et al. 2008). As such, upfront investment can be a substantial obstacle to implementing EEMs. Similarly, as industrial firms tend to heavily discount the future benefits of EEMs resulting from lifecycle operational savings, they may be inclined to only consider EEMs with the lowest upfront costs (Willis Energy and RMI 2009).

- *Lack of strategic priority (constrained capital availability)*: For industrial firms who are on the high end of a business cycle, experiencing increasing returns and expanding production, the availability of upfront capital can be limited by a preference to invest in measures that increase output and market share (Ross 1990; Elliot et al. 2008). If the EEMs do not directly contribute to the latter, they are often considered a low priority (Elliot et al. 2008). Similarly, disproportionately high rates of return are often applied to small and medium discretionary energy efficiency investment in firms that ration capital (Ross 1990). In capital rationing, a fixed sum is allocated for discretionary operations and maintenance expenditures. EEMs have to compete with other measures that are perceived to have a greater impact on production capacity, product quality and product flexibility. EEMs are hence deemed a low priority unless they are highly profitable (Ibid.) In general, it has been documented that industrial firms will postpone equipment maintenance, equipment upgrade investments and cost-cutting measures as long as possible in favour of short-term measures that increase market share as the opportunity cost associated with the latter is considered higher (Ross 1990; Brown 2001; Sandberg 2003).

- *Energy costs*: The avoided cost of energy in large part determines the value proposition, and hence priority, of investment in EEMs. In jurisdictions and industrial sectors where energy rates are low relative to operating costs, industrial firms have less incentive to make energy efficiency a priority (Brown 2001). As well, if demand for an industrial commodity is tight enough (i.e. demand is high and supply is constrained), firms can pass energy costs along to consumers, minimizing the motivation to invest in energy efficiency (Elliot et al.

2008).

- *Lack of suitable financing*: A large debt load, pre-existing debt covenants and lack of creditworthiness can limit the ability of firms to obtain low-cost financing even if the measures are low risk and they reduce operating costs enough to service a sizeable percentage of the debt (EVO 2009). The site-specific and irreversible nature of some EEMs can prevent their use as collateral, further limiting financing options (Willis Energy and RMI 2009).

Limited internal resources

Similar to capital, labour and technical capacity are finite in industrial firms and can be constrained by a customary preference to prioritize core operations and projects that increase output and market share (Ross 1990; Brown 2001).

Operational and capital investment cycles

As noted in section 3.4, there are three levels of decisions made in industrial facilitates that affect energy use: (1) the design of process and supporting energy sub systems, (2) procedures for procurement, operations and maintenance and (3) the decisions of equipment operators (Russell 2009). While the latter two levels of decisions are made on a regular, reoccurring basis (a year or less), major equipment refit cycles correspond with longer operational cycles (typically 4-7 years) (Elliot et al. 2008). Operation cycles are based on the need for deep maintenance, changes in product mix and the modernization of technology at a facility (Ibid.). Industrial firms are risk averse to interrupting a process for modification until the end of an operational cycle. Major capital investment decisions coincide with the end of operational cycles and present an opportunity for firms to improve the energy efficiency of their operations at a relatively low incremental cost (Ibid.). Within an operational cycle, major energy efficiency investments may be a low priority unless there is equipment failure. That said, routine outages for maintenance present an opportunity for DSM administrators to incent the upgrade of interchangeable components (e.g. motors, pumps, etc.).

Concerns about performance reliability

Apprehension over the performance of energy efficiency technologies acts as a barrier to EEM adoption. Less mature technologies, custom and comprehensive measures may require break-in periods and experience operational problems that make them a liability to the firm (Ross 1990). As well, the operational savings of particular EEMs can be variable depending on actual performance of the EEM and usage, posing an additional financial risk factor for firms investing in EEMs (EVO 2010).[39]

Organizational Dynamics

Beyond capital constraints and performance barriers, organizational dynamics within an industrial firm can limit investment in energy efficiency. Where there is a lack of a strategic corporate energy management policy establishing clear authority and accountability for energy-related decisions and guiding standard operating, procurement and maintenance procedures, EEMs will likely be a low priority (DeCanio 1993; Sandberg 2003; Russell 2009). Likewise, if there are silos within an organization between operational, management and executive levels that inhibit the communication of information on energy performance, there is likely to be less organizational capacity to recognize the value proposition in EEM investment (Russell 2009).

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[39] Detail on methods for calculating energy savings is provided in section 4.4.2.

4.4.2 Free Ridership

The adoption of energy efficient equipment occurs in the absence of utility or governmental intervention as a result of consumer awareness, capital stock turnover, technological advances and market forces (Jaccard and Rivers 2011). To maximize net energy savings, DSM program administrators strive to minimize EEMs that customers would naturally undertake themselves, and thereby minimize "free riders" (CBP 2004). Free riders dilute program dollars and if not managed properly, pose a risk of low net customer response to DSM program incentives.

Determining free ridership can be complex and often controversial due to the particular nature of participant market conditions, as well as conflicting values regarding market intervention and policy objectives (Ibid.). While it is widely agreed that program participants who would implement EEMs without an incentive, or "pure" free riders, should be avoided, there is a grey area when it comes to participants who would have implemented a similar but less efficient EEM or participants who would eventually implement an EEM but were incented to do so earlier (EPA 2007).[40] With respect to the latter example, known as "partial" or "deferred" free riders, it has been argued that DSM programs are likely to shift the timing of EEM investment but not the overall magnitude of energy savings (Rivers and Jaccard 2011). That said, given the DSM resource acquisition imperative to avoid cost premiums associated with purchasing or developing new supply resources to meet demand growth, the temporal dimension of EEM implementation can be as important as the overall net energy savings magnitude. Finally, the "spillover" effect is cited as a counterbalancing force to free riders. In the spillover effect, energy efficiency

[40] There is often a greater tolerance for free riders in market transformation programs as providing incentives broadly to a market is required in some instances to achieve sufficient market share (including a share of free riders) to gain public acceptance for regulations (Prahl and Schlegal 1994; Pape-Salmon 2011).

programs increasing general awareness and availability of EEMs in the market and result in a percentage of non-participants ("free drivers") implementing EEMs (Ibid.; IEA 2005).[41]

Minimizing free riders is the large non-residential sectors is challenging due to the level of end-user sophistication (CBP 2004). While industrial firms, for example, implement a range of custom EEMs in spite of program influence, there is also evidence that there are numerous cost-effective EEM opportunities that they do not adopt without program support (Ibid.). O&M measures are a case in point, as many customers would in theory pursue these low-cost, low payback measures naturally. Many O&M measures have low adoption rates however, compressed air maintenance as a primary example (Ibid). Another challenge with respect to free riders in custom and performance incentive programs is that opportunities for significant efficiency improvement are based on equipment replacement (Elliot et al.) As noted in the previous section, major energy efficiency improvements made at industrial facilities occur at the end of operational cycles in the context of major equipment refits (typically 4-7 years) (Ibid.). As such, industrial energy efficiency improvements are often incremental in nature. For energy efficiency programs offering incentives beyond incremental costs in this context, there is a heightened risk of "partial" free riders.

4.4.3 Development Risk Management

Options cited for managing DSM development risk in industrial (and non-residential in general) incentive programs fall into three categories: (1) incentive timing and levels, (2) third party resources, and (3) contractual terms and eligibility requirements. The objective of these options

[41] Net energy savings are typically calculated by subtracting an estimate of savings resulting from free riders from gross energy savings figures and then adding an estimate of savings resulting from the spillover effect (U.S. EPA 2008).

in sum is to incent net program participation while minimizing the impacts of project implementation delays or failures.

Incentive timing and levels

DSM administrators can address development risk factors by modifying the level or timing of financial incentives to regulate program participation and limit free riders (CBP 2004). Reducing upfront capital requirements and the overall payback period for EEM investments are primary points of leverage to incent participation from customers who are at the low end of their business cycle and have constrained access to capital. Likewise, for customers who are in a growth phase, reducing overall payback of EEMs can make those measures more competitive with investments that strictly increase output (BC Hydro 2009). Upfront and high incentive levels, however, both entail their own risk as the former is based on estimated energy savings that may not materialize and the latter increases the overall financial expenditure of the utility. To circumvent capital constraints altogether, DSM program administrators can focus financial incentives on non-capital based measures like O&M improvements (Elliot et al. 2008; Chittum et al. 2009). Finally, DSM program administrators can maximize participation by allowing for longer project development lead times. Longer lead times provide flexibility for industrial firms to plan and implement EEMs within the context of standard operational and investment cycles (Elliot et al. 2008; Chittum 2009).

DSM program administrators can employ a number of incentive approaches to limit the risk of free riders. These include setting a minimum project payback threshold to limit EEMs that are otherwise likely to be undertaken by customers without incentives (e.g., incentives to buy down the payback to two years, no less), providing incentives for the incremental cost of high efficiency equipment above current standards (e.g., to up sell savings beyond those associated with capital stock turnover) and establishing higher incentive levels for measures known to have low naturally occurring levels (CBP 2004). With respect to the former, as noted, some EEMs have very low paybacks yet still have low adoption rates, reiterating the difficulty of addressing free ridership in the industrial sector (Ibid). As well, minimizing partial or deferred free riders in resource acquisition programs that provide incentives greater than incremental costs is arguably impossible. As such, the cost of a certain percentage of free riders in these programs is considered an acceptable trade-off for the benefit of immediate energy savings.

Contractual terms and eligibility requirements

Development risk management options also include contractual terms like liquidated damages provisions that mitigate development risk impacts by imposing a financial penalty on participants if EEMs are not brought online in a timely manner (Goldman and Kito 1995). Conversely, DSM program administrators can choose to ease eligibility requirements, for example credit worthiness, to maximize participation of firms who are in a decline phase and have poor credit, but yet are considered solvent in the mid and long term.

Third party resources

To address participant resource constraints and minimize financial risk exposure, DSM administrators can include energy efficiency service providers as eligible participants who offer turnkey services to host costumers, including providing or arranging for EEM financing. As detailed in chapter 2, ESCOs in particular have been active participants fulfilling this role in a number of large, non-residential energy efficiency programs. ESCOs will often assume a portion of project and development risk for host customers, ameliorating the latter barriers to EEM investment. That said, the ESCO market in the North American industrial sector has been historically narrow (Elliot 2002). The smaller market has been attributed to limited ESCO capacity to work on industrial processes and limited replicability of EEM designs (Elliot 2002). On the other hand, engineering firms and vendors who have specialized in the industrial sector have had greater success offering turnkey energy efficiency services and often bundle financing with their offers (Ibid.).

4.5 Performance Risk

Goldman and Kito (1995) define performance risk as the risk that planned energy savings do not persist over the effective life of implemented measures. Performance risk includes the following components: (1) host customers substantially change operations or go bankrupt, (2) M&V methods are insufficient to accurately document energy savings, (3) deficiency in technology or practice and (4) lack of maintenance or optimization of energy system improvements. Accordingly, what follows is a review of factors that contribute to performance risk, specifically financial instability in the large industrial sector, challenges to measuring energy savings in industrial operations and the lack of energy performance feedback at operational and management levels in industrial operations. The section concludes with a survey of DSM performance risk management options.

4.5.1 Large Industrial Sector Instability

The North American industrial sector has experienced considerable instability over the past decade as a result of globalization, economic recession and industrial consolidation (Elliott et al 2008). The latter has created an uncertain environment for DSM incentive programs as there is an increased probability that industrial firms will make substantial changes their operations (e.g shutter capacity or whole facilities) or potentially go bankrupt. In both events, DSM program administrators, and ratepayers more broadly, risk losing investment in EEMs as well as energy savings from the measures.

Large industry has been transformed recently by volatility in commodity markets as a result of increasing supply from emerging lower-cost regions, stagnating demand in domestic markets due to the current recession and rapidly growing demand in emerging markets (e.g. Brazil, Russia, India and China). Many firms who have seen prices for their products drop as result of the latter trends have been inclined to defer investment in facility upgrades, including energy efficiency improvements (Chittum et al. 2009). In these cases, corporate decision makers are reluctant to reduce near-term cash reserves, liquidity and flexibility (Ibid.). In the worst case examples, industrial firms who are faced with slumping demand and high input costs (e.g. energy, labour or inefficient facilities) have gone bankrupt. Other firms who have moved to expand capacity or tighten markets to capitalize on the growing demand (Elliot et al. 2008). Industrial consolidation, through mergers and acquisitions, has been another force of change in the industrial sector. Faced with uncertain market conditions and opportunities to maximize overall efficiencies, firms have shuttered or altogether closed facilities in order to reallocate production from higher to lower cost plants (Elliott et al 2008; Chittum et al 2009.). Examples of these trends in BC are considered in section 4.6.1.

4.5.2 Challenges to Measuring and Verifying Energy Savings in the Industrial Sector

Measurement and verification (M&V) plays a key role in ensuring utility ratepayer funds pay for real and persistent energy savings resulting from DSM incentive programs. M&V represents a spectrum of in-program methods for determining the energy savings from EEMs, as well as verifying they are operational and functioning as intended. In addition to determining energy saving, M&V allows utilities to monitor, track and document program effectiveness for the improvement of program design. M&V also creates an opportunity for utility customers to monitor energy performance in their facilities for the improvement of operations. A central challenge to measuring and verifying energy savings in industrial DSM incentives programs is the complex nature of industrial loads. The industrial sector is dominated by process-based, variable loads that are strongly driven by production fluctuations. Determining baseline energy demand in in these conditions can be resource intensive and poses a risk to the accuracy of energy savings. Process systems pose challenges to measuring hard to isolate EEMs. The following section will first provide background on M&V methodology, specifically the International Performance, Measurement and Verification Protocol M&V Options A-D, and then detail the challenges to applying the latter to ensuring the performance of EEMs in the industrial sector.

International Performance, Measurement and Verification Protocol

Given the importance of measuring the impact of EEMs to utilities and DSM developers, numerous standard protocols for measuring and evaluating energy savings have been developed over the years. The *International Performance, Measurement and Verification Protocol* (IPMVP), developed by the US Department of Energy in the mid 1990s and refined through the early 2000s, is widely adopted and adapted by electric utilities for M&V in North America, including BC Hydro. The IPVMP has the dual objective of standardizing and streamlining performance measurement by offering flexible "best practice" options and procedures designed to match program costs, energy saving magnitudes, uncertainty, as well as address technology-specific characteristics and requirements (EVO 2010). In addition to verifying the reliability of EEMs, the IPMVP is designed to minimize uncertainty and transaction costs associated with performance measurement and therefore maximize the recognition of energy savings and uptake of EEMs. The IPMVP forms the framework for in-program M&V used to measure performance in three of the four programs included in this study. Its particular application in each program has implications for M&V costs, distribution of performance risk and the reliability of energy savings determinations.

There are four primary IPMVP performance measurement options, Options A, B, C and D. IPMVP options can be divided into two main categories: (1) Retrofit Isolation and (2) Whole Facility. As addressed in detail below, Retrofit Isolation options measure energy savings directly and Whole Facility options measure energy savings at the meter or sub-meter level.

All of the options determine "avoided energy use" by calculating (*Baseline Energy Use + or – Adjustments) – Post Retrofit Energy Use* (EVO 2010). As Figure 2 illustrates, baseline energy use is a model of what energy use *would have been* in the absence of the EEM.

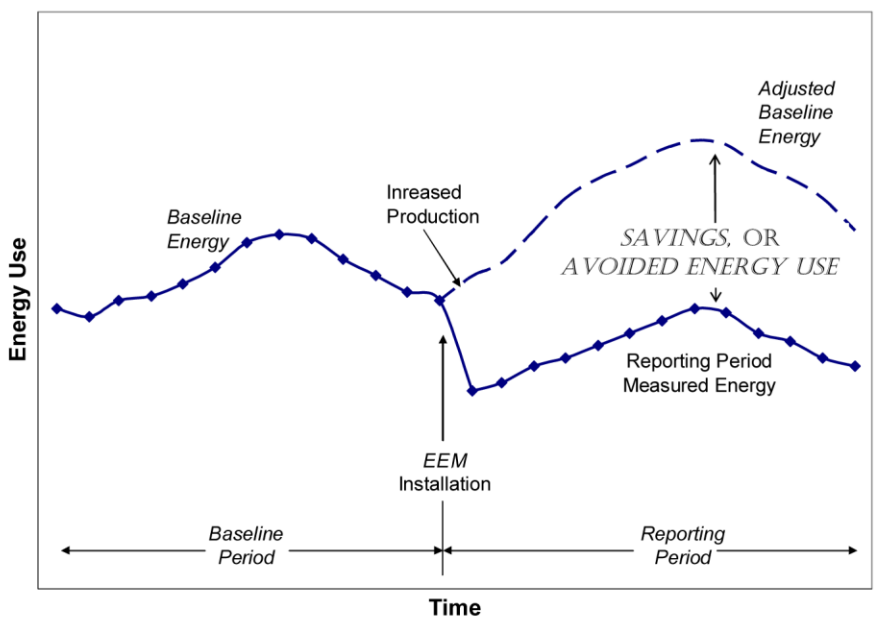

Figure 2. Determination of Energy Savings

Source: Efficiency Valuation Organization, 2010

The reporting period is the interval of time following the EEM where actual energy use is recorded at the equipment, sub-facility and/or facility level. If energy driving factors such as weather, production output or operating hours are expected to change routinely during the reporting period, then the baseline model has to be adjusted to allow for an accurate comparison with reporting period conditions. Depending on the operational nature of the EEM, baseline model adjustment can be as simple as multiplying the hours of operation in the reporting period by electrical load of the replaced equipment or it can require multi-variable regression analysis correlating baseline energy use with two or more energy driving factors during the reporting period (Kissock and Eger 2008; EVO 2010). Non-routine adjustments to the baseline model are also required if substantial changes affecting energy use are made to the facility, operation of equipment or product mix (EVO 2010).

The baseline period is designated to capture a full operating cycle, from minimum to maximum energy use, of the equipment or facility in which the EEM is being implemented.[42] The IPMVP recommends that the length of the reporting period be at a minimum one operating cycle, but also advises that consideration be given to the effective measure life of the EEM and the possibility of degradation of the initially achieved savings over time. The protocol notes that performance of EEMs immediately following installation may be well known, but the actual persistence of measure performance is often less understood. Likewise, while many EEMs have established performance characteristics, measures that are newer to the market have less of a track record, increasing uncertainty in the determination of energy savings when the reporting period is relatively short. In practice, the reporting period for different EEMs can range from an

[42] Operating cycles can vary widely depending on the EEM. As an example, the IPMVP cites EEMs that target building energy use, which may require twelve months of data to assess the effects of seasonal weather conditions. On the other hand, a compressed air system may only be driven by weekly production cycles, so one week's data would be sufficient to define baseline performance.

instantaneous measurement following implementation to the end of the measure's useful lifetime, although an average is likely to be closer to a year or two (EVO 2010).

IPMVP Options A and B are designed for EEMs that can be metered in isolation from the rest of the facility. The IPMVP protocol specifies that Option A should include the measurement of at least one energy parameter, usage or electrical load, while Option B entails the measurement of all parameters. In a review of utility DSM literature and interviews with DSM program administrators, it was determined that Option A frequently entails no measurements, with savings based on site inspections (verification) and engineering analysis alone. In practice Option A and Option B thus represent the bookends of a continuum of stipulated savings and measured savings. Option selection is determined in part by the specifications of the EEM, but also, as addressed in section 1.5.1, on a utility assessment of cost and risk.

Accordingly, an example of Option A would be the installation of a high efficiency constant-speed exhaust fan motor that operates under a constant load on a regular schedule. If both usage and load are constant, one or both parameters can be stipulated with relative confidence (EVO 2010). Option B is used, then, when one or both of the energy parameters is variable in the baseline and or reporting period. A facility lighting retrofit is an often cited example of an EEM with one parameter being measured and one being stipulated. Fixture wattage is taken from standard tables and operating hours are measured with lighting loggers. A variable speed drive upgrade to a motor is an example of an EEM where both usage and load are typically measured. For both option A and B, the IPMVP provides guidelines on the degree to which short-term or continuous measurement should be employed which depends on uncertainty in equipment operation (EVO 2010).

The second set of options, Option C and D, determine energy savings at the facility or sub-facility level. Option C is typically used when EEMs are comprehensive, complex, behavioural, interactive or otherwise difficult to isolate from the rest of the facility. Examples include multiple EEMs at one site, control systems or improved O&M procedures. Option C determines energy savings at the meter level by analyzing the difference between measured energy use and baseline energy use in the reporting period. If routine changes in energy driving factors are expected in the reporting period, for example throughput (e.g. tonnes, pallets, cases), quality (e.g. freeness of pulp) and production output (e.g. litres, tonnes) in industrial facilities, then those factors must be tracked and inserted into the baseline model to produce adjusted baseline energy use. Option C employs continuous measurement, hourly, daily or monthly, throughout the recommended minimum year baseline period and reporting period. For reporting periods less than two years, IPMVP recommends that EEMs have expected savings greater than ten per cent of baseline energy use in order to confidently discern energy savings from unexplained or random variation in the baseline data. Option D generally applies to new or substantially modified facilities or sub-facilities where no meter exists to establish the baseline period. In Option D energy savings are determined by developing a software simulation of energy use at the whole facility or sub-facility level. The simulation is calibrated over time as meter data becomes available (EVO 2010).

Challenges to Industrial M&V

A central challenge to establishing reliable energy savings in industrial DSM incentive programs is the diverse nature of industrial loads. Unlike the commercial and institutional sectors where energy loads are typically the result of predicable building use, the industrial sector is characterized by process-based, variable loads that are strongly driven by production fluctuations. Variable loads make baseline determination in the reporting period complex. Process systems are multifaceted and interactive, limiting the direct sub-metering of retrofitted components (Kissock and Eger 2008; EVO 2010). As a result, estimating and measuring energy savings in the industrial sector is subject to a greater degree of uncertainty than other sectors. If engineering calculations are the exclusive basis for which energy savings from EEMs are established by a utility, uncertainty in estimates can lead to a less reliable determination of energy savings, and by extension over or under payment of incentives. Uncertainty in estimates can also limit the capacity for utilities to evaluate the effectiveness of measures and pose the risk of gaming by less honourable program participants who may deliberately over estimate savings or miss-specify engineering equations (CBP 2004). Similarly, uncertainty in measurement can also lead to less reliable energy savings and over or under payment of incentives, however, as detailed in the discussion of DSM performance risk treatment options below, utilities can minimize uncertainty through the application of rigorous M&V.

4.5.3 Lack of Performance Feedback

Research has shown that while many industrial firms have enterprise resource planning and control systems capable of monitoring energy use, they frequently do not integrate energy efficiency as a relevant performance criterion (NRCAN 2003; Bunse 2010). In many cases, industrial managers operate under the assumption that their plants are as energy efficient as possible and lack the overall information to indicate otherwise (Taranto et al. 2007).Without energy performance feedback at an operational and management level, a firm's capacity to detect poor performance, optimize systems and practices, and ensure the persistence of EEMs is diminished (NRCAN 2003).

Energy performance is tracked using a wide configuration of metering, sub-metering and software tools that track and consolidate energy use and key energy driving factors in a facility, system, or process. Using methods that conform to IPMVP Option C, the software calculates a real-time baseline model against which energy performance and energy savings from EEM improvements can be monitored and measured. Performance analysis calculates the ongoing difference between actual and baseline model energy consumption. In sum, these systems are referred to as performance tracking systems, energy management information systems, or enterprise energy management systems. They are designed to be integrated with existing control or planning systems so they be accessed by at multiple levels of an organization, including operators and decision makers (NRCAN 2003; Tarnato 2007; Bunse 2010; EVO 2010).

Energy performance tracking allows operators and managers to set performance targets and see real time, continuous progress (Taranto et al. 2007). Automated alerts inform operators when there are anomalies or performance is poor at a facility, system or sub-system level (Ibid.). Tracking also provided diagnostic data to optimize performance and identify operational issues (Ibid.). Historical performance data allows firms to trend operational efficiency and benchmark performance (Ibid.). Together, this functionality helps ensure the persistence of EEMs, whether they be technological or operational. In their study on using real time data to benchmark, optimize and sustain system energy efficiency, Taranto et al. (2007) note that lacking a performance tracking system is comparable to operating an automobile without a dashboard (Ibid.).Without performance feedback, DSM performance is at risk.

4.5.4 Performance Risk Management

Options cited for managing DSM performance risk fall into three categories: (1) eligibility criteria, contractual performance requirements and incentive design, (2) M&V and (3) performance enabling measures. All three categories share the objective of ensuring the persistence of energy savings, while the first category also has the objectives of transferring the risk of underperformance away from ratepayers and mitigating related impacts.

Eligibility and performance provisions

Eligibility criteria can serve as a gate for DSM administrators to minimize projects that are lacking sound engineering and financial fundamentals. Creditworthiness requirements are designed to exclude participants who are financially unstable and thus pose a risk that EEMs may cease to provide energy savings due to bankruptcy or substantially changed operations. Likewise, security requirements and liquidated damage provisions can provide compensation in the latter scenario (Goldman and Kito 1995). Security is typically drawn down over the contract term as energy savings are acquired. Contract length reflects the degree to which participants are responsible for the persistence of energy savings from EEMs and can be extended to align with the effective life of measures.

As noted, paying incentives for measured energy savings ensures that ratepayer funds are used for real and persistent reduction in energy consumption. Two variations of this risk management option are central to performance incentive programs. The first, and most rigorous, option entails incentives paid retroactively for measured energy savings. The second, and least participation inhibiting option includes a portion of the incentive paid upfront with the DSM administrator reserving the option to prorate the final incentive levels or require reimbursement based on M&V results. In both cases, participants are entering into performance contracts with the DSM administrator to deliver guaranteed energy savings.

Measurement and verification

Within each IPMVP measurement approach there is a range of options to minimize energy savings uncertainty that in sum involve increasing the amount and quality of operational data being measured. One option is to increase the scope of measurements or sample size, adding for example additional sub-meters or data loggers to multiple energy use parameters of an EEM, or series of EEMs. Another option is to increase the frequency of measurement, allowing for greater time series resolution when a load is highly variable. Similarly, correlating a greater number of energy driving factors with baseline energy use, within limits, allows for greater confidence in determining energy savings in variable load conditions. Finally, increasing the duration of measurement is an option for minimizing the impact of short-term unexplained energy use variations on baseline data, as well as reducing uncertainty around the persistence of EEMs in general (EVO 2010).

While the aforementioned options are available to DSM administrators, maximizing M&V rigour can be resource intensive and intrusive to customer operations. As such, administrators pursuing resource acquisition targets have developed M&V strategies that balance the objectives of maximizing energy savings certainty with program resources (CBP 2004). In practice, these strategies entail minimizing M&V costs by tailoring measurement rigour to an EEM’s size and contribution to the cumulative uncertainty in estimated savings for the overall program (Ibid.). M&V resource requirements are minimized by using deemed values in calculations of energy savings for EEMs with well-known parameters and limiting the length of measurement, where necessary, to one operating cycle (thus only measuring energy savings for a fraction of a measure’s effective life).

Performance enabling measures

Performance risk management options also include the provision of performance tracking tools that can detect EEM underperformance and enable energy management practices. Performance tracking systems can provide the dual benefit of providing performance feedback and streamlining M&V. In most DSM programs, M&V data on EEM performance flows in the direction of the DSM administrator, however, as the IPMVP notes, this information can additionally be used "to improve or optimize the operation of the equipment on a real-time basis, thereby improving the benefit of the energy efficiency measure itself (EVO 2010)." As noted in section 4.5.3, in many cases the systems capable of measuring and communicating energy use are already in place in industrial facilities, for example distributed control systems and manufacturing execution systems, and need only to be integrated with software capable of consolidating, analyzing and communicating energy use and key energy driver data to determine energy system performance (NRCAN 2003; Bunse 2010; EVO 2010).[43] Coupling M&V efforts with the development and integration of energy performance monitoring capabilities can thus provide operational benefits for industrial participants through performance feedback and economic efficiencies for DSM administrators who can assess performance data to determine energy savings from implemented EEMs. These systems also provide an opportunity for DSM administrators to leverage energy management frameworks that are based on energy performance feedback, to further ensure the persistence of energy savings.[44]

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[43] Energy system performance data can then be further integrated in higher-level enterprise resource planning systems to maximize the visibility of energy performance at multiple levels within an industrial firm (Bunse 2010).

[44] For example, *ISO 50001 – Energy Management system standard,* which applies a continuous improvement framework to energy management for which monitoring and measurement systems are a key requirement. BC Hydro's Monitoring, Targeting and Reporting (MT&R) program and NRCAN's Energy Management Information System (EMIS) are other examples. As discussed in section 2.6, BPA's Track and Tune program is an example of coupling M&V with the development of energy performance monitoring systems for customers, and is the foundation of BPA's energy management portfolio.

4.6 BC Industrial DSM Risk

The following section of this chapter summarizes large industrial electricity use in BC, followed by an assessment of key DSM development and performance risk factors in the large industrial sector. The latter is used to develop a BC large industrial DSM risk factor profile in the concluding section of this chapter.

4.6.1 BC Large Industrial Electricity Use Characteristics

Like the Canadian industrial sector as a whole, the BC industrial sector remains largely based on energy intensive resource extraction and processing. The pulp and paper and mining industries (coal, metals, upstream oil and gas) have historically been the largest energy users, consuming 43 per cent and 12 per cent of secondary energy respectively in 2008 (NRCAN 2011).[45] While the type of energy used varies widely across the industrial sector, the pulp and paper, mining and chemical subsectors rank among the top three largest electricity consumers in BC (NRCAN 2011). Electricity in these subsectors is primarily used as a source of motive power, for example to power motors for pumps, fans, conveyers, and compressors (NRCAN 2010). A good portion of the electricity consumed by these subsectors is generated on site, particulary by the pulp and paper industry who combust wood waste and pulping liquor to generate steam and power. For the balance of elecricity demand, all of these major industrial subsectors are primarily supplied by BC Hydro at transmission service volatage.[46]

[45] Note the NRCAN Comprehensive Energy Use Database combines data from BC and the Canadian Territories because of confidentiality issues with the small population size of Territorial data. With respect to energy, it was noted by NRCAN that the footprint of the territories is minimal and does not significantly skew data. 2008 is the most current data available.

[46] 60,000 volts or higher; Rate Schedule 1823

In 2009, BC Hydro transmission service customers purchased 13,600 GWh of electricity and accounted for twenty six per cent of BC Hydro's total domestic electricity sales (BC Hydro 2010). Figure 3 shows the transmission service distribution of electricity consumption by industrial subsector.

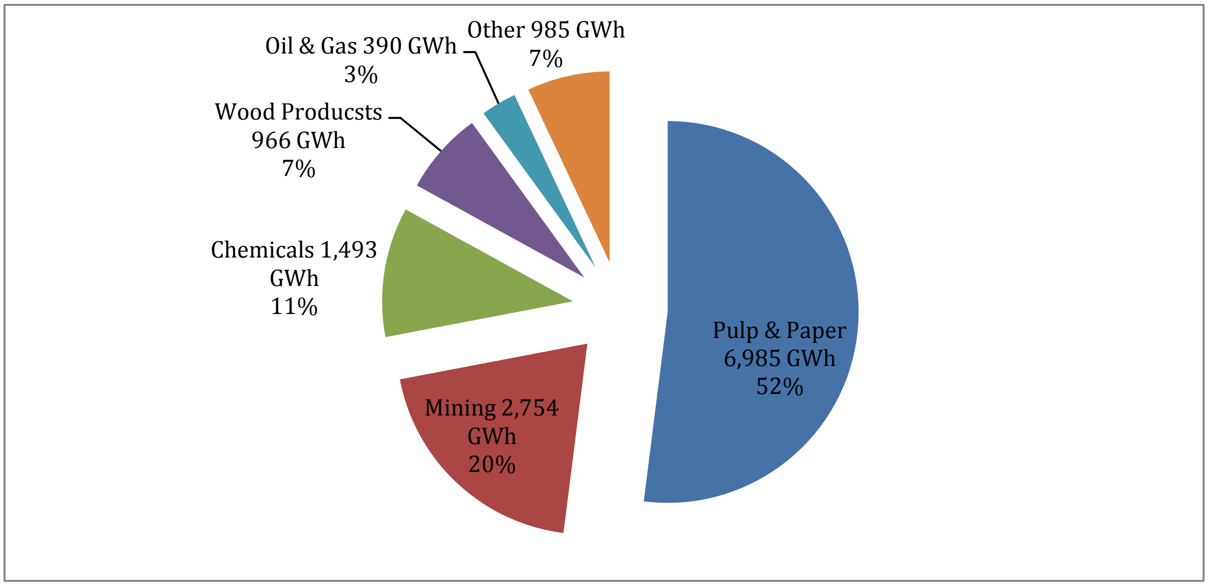


Figure 3. BC Distribution of Electricity Consumption by Industrial Subsector in 2009

Source: PSP-T Business Case II, BC Hydro 2009

The transmission service is notably dominated by forest product-related subsectors. The pulp and paper, wood product and the chemical subsectors (whose primary market is the pulp and paper industry) comprised close to seventy per cent of BC Hydro's transmission rate sales in 2009 (BC Hydro 2009). The coupling of the forestry related sectors in the face of changing market conditions has important implications for the volatility of business cycles across each respective industry. Also of note, of the 133 transmission service customers in 2009, the ten largest industrial firms accounted for 73 per cent of the total transmission consumption. Conservation potential in the large industrial sectors is thus concentrated within a relatively small number of industrial firms (BC Hydro 2009).

4.6.2 BC Sector Instability and Constraints to Energy Efficiency Investment

The business cycles of large industrial firms in BC have been historically volatile and highly sensitive to export commodity markets. Commodity markets are in turn driven in large part by economic conditions in the US, China and Japan, as well as the relative strength of the Canadian Dollar. In 2010, international exports accounted for 26 per cent of BC's gross domestic product (GDP), 76 per cent of which were commodities (BC Stats 2011a, 2011b). 85 per cent of international export commodities were from the forestry subsectors and mining subsectors (BC Stats 2011b). As noted in section 4.4.1, the growth or decline of industrial firms can affect the relative priority given to energy efficiency investments and by extension, uptake of DSM program offers. Figure 4 illustrates the volatility of international export commodities, and by extension, industrial business cycles in each subsector over the last decade.

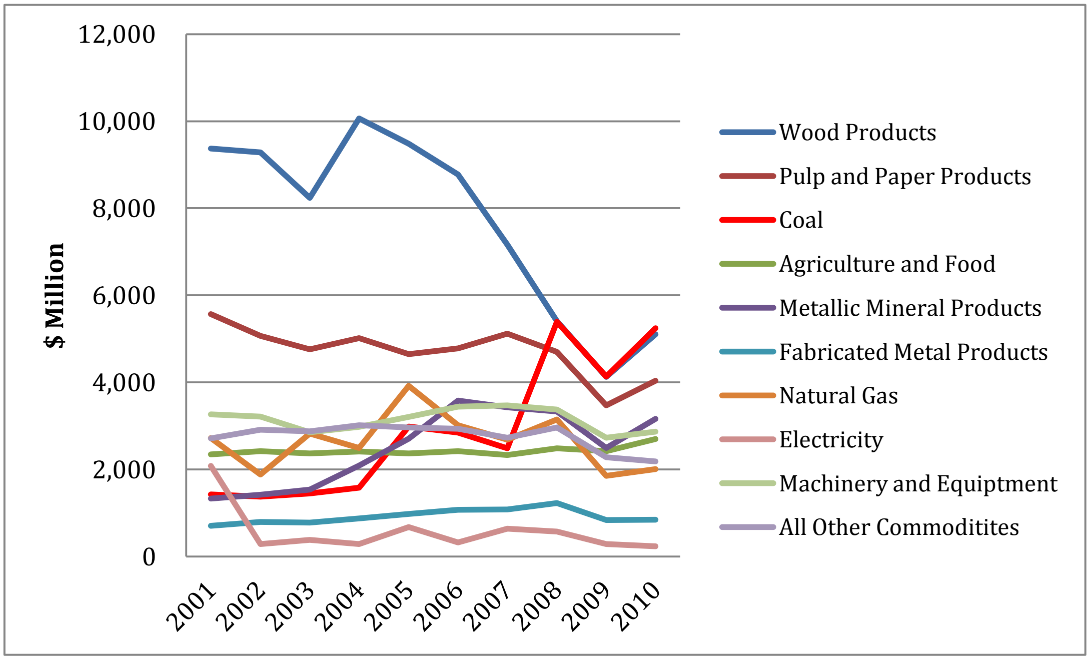


Figure 4. Select BC International Commodity Export Trends 2001-2010

Source: Exports (BC Origin) 2001-2010, BC Stats 2011d

Focusing on BC Hydro transmission service customer industries, it clear that both the mix of export products and markets for BC exports are shifting. The declining percentage of forest product exports, BC's traditional major export group, is striking. Softwood exports have experienced a decline for more than a decade as a result of a stagnating Japanese economy, US trade policies, international competition, the growing value of the Canadian dollar and most recently, the precipitous decline of US housing starts (BC Stats 2011c). The pulp and paper industries have also experienced a downward trend as a result of the decline in demand for newspaper, high valued Canadian dollar, strong foreign competition, US subsidies and increased production costs (BC Stats 2009). Notably, the rise in costs is due in part to a shortage of lower-cost wood chips, which is itself the result of reduced output at lumber mills in response to falling demand. Pine beetle damage to pine forests and competition from biofuel producers have also been factors limiting the supply of low-cost fibre (BC Stats 2009).

While the forest product subsectors have experienced general decline, coal and metal mineral exports have seen sustained growth. This growth has been driven in large part by demand from Pacific Rim countries, particularly China in recent years, whose expanding steel and manufacturing industries require increasing supplies of metallurgical coal and copper (BC Stats 2011c; Port Metro Vancouver 2010).

Both the forest product and mining subsectors experienced a decline, along with almost all commodity-based industries, through the global economic slowdown of 2008-2009 as result of lower international commodity prices. Commodity export markets have since improved over the course of 2010 and 2011 in spite of a continued historical low in US exports, BC's largest trading partner (BC Stats 2011c). BC's growing trade with Asia has offset much of the reduced US demand for BC raw commodities. Mainland China has been the biggest driver in renewed demand. Exports of pulp, softwood lumber, coal and metal minerals, all inputs into China's burgeoning manufacturing sector, increased 63 per cent in 2010 from the year prior, representing 14 per cent of total shipments (BC Stats 2011c).

Whether the current economic recovery will continue remains to be seen given the volatile state of international markets. BC's export market has certainly diversified, making it less sensitive to US and Japanese markets. Industries like the pulp and paper and softwood lumber that appeared to be on the brink, have modestly improved for the time being, while coal and metal mining have experienced a boom. At a high-level, it is clear is that resource industries in BC are deeply affected by commodity cycles that create an imperative to either increase or reduce production capacity. These swings result in varying support for DSM programs and create challenges for program design as the strategic capital priorities for industrial firms are moving targets and different in each subsector. The swings also create an opportunity for DSM, particularly for subsectors in recovery, as the value proposition that EEMs present to industrial firms is enhanced by their capacity to increase competiveness through reducing operating costs.

Accordingly, the implications for managing DSM risk in the BC large industrial sector are twofold: (1) incentives should be tailored to the business cycle of industrial firms to effectively overcome subsector-specific barriers. In the mining subsectors, for example, capital availability for EEMs is a chief barrier for DSM uptake, as EEMs have to compete with the high rates of return available from investment in increased production. Conversely, in the pulp and paper sector, capital accessibility is a chief barrier as industrial firms have limited capital resources to implement EEMs. Similarly, low credit ratings pose a problem for the pulp and paper industry both in terms of access to suitable financing for EEMs as well as participation in BC Hydro incentive programs. Currently only two of nine pulp and paper customers pass BC Hydro's credit policy to make them eligible for Project Incentives (BC Hydro 2009). In both mining and pulp and paper, limited internal resources pose a substantial barrier to program participation. (2) Given the instability of the large industrial sector, measures should continue to be taken to ensure utility DSM investments will yield energy savings and not stranded assets should firms substantially change their operations or go bankrupt. These measures, whether contractual or part of the program designs themselves, should be balanced with an assessment of customer acceptability to ensure they don't become a barrier to customer participation themselves.[47]

4.6.3 BC Large Industrial Sector Energy Savings Potential

In 2007, BC Hydro commissioned a Conservation Potential Review of all of its customer sectors. In the industrial sector, the report found 7,741 GWh/year, 1,531 GWh/year, and 675 GWh/year respectively of economic, upper achievable and lower achievable potential annual energy savings by 2021. The most significant achievable savings opportunities were identified in measures that addressed process end use in the mechanical pulp subsector, as well as pumps, compressed air, fans and blowers, and lighting end uses in all subsectors (BC Hydro 2007). In 2009, BC Hydro updated the energy saving potential for transmission service customers on a site-by-site basis. Figure 5 shows the identified potential by end use from 2009-2011 for transmission service customers, totalling 748 GWh/year (BC Hydro 2009).

[47] These observations are reinforced by results provided from a survey of BC large industrial customers conducted for this study. Four of the largest industrial electricity users, representing pulp and paper, metal mining and coal mining industries were asked to rate barriers to greater industrial customer participation in BC Hydro's Project Incentive program. Limited internal resources to design and execute EEM projects and low electricity rates were rated the highest, followed by concerns about the risk of project performance, upfront cost requirements and high internal rate of return requirements for EEM investments. Due to the small number of firms surveyed, it is not possible to make any statistical generalisations across the sector, but the results nevertheless illustrate conditions for the province's largest electricity consumers. Industrial firm responses to the performance incentive program models are detailed in section 6.5.

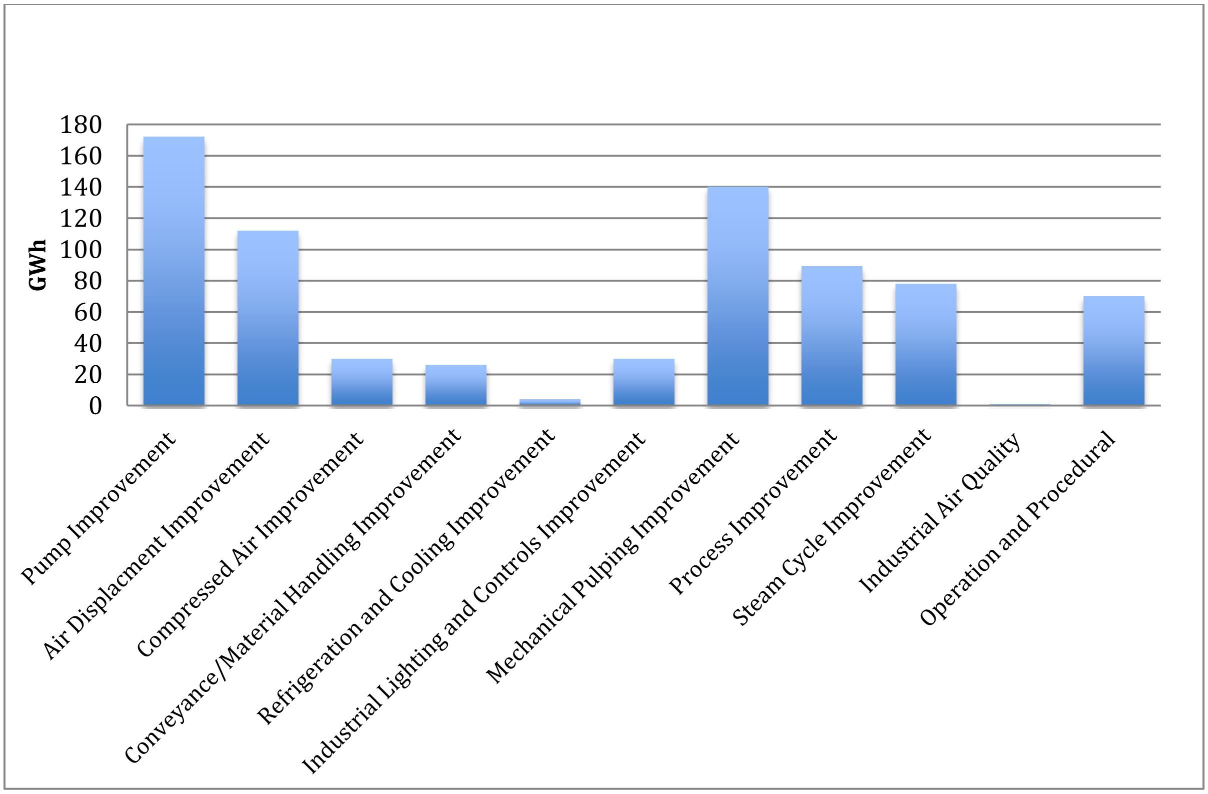


Figure 5. Achievable Energy Savings Potential for Transmission Service Customers by End Use 2009-2011

Source: PSP-T Business Case II, BC Hydro 2009

Ninety one per cent of the energy saving potential is from hard-wired equipment measures requiring capital investment. Notably, process improvement (including mechanical pulping improvement) represents the largest potential. As noted in section 4.5.2, the wide ranging baseline and efficiency characteristics of industrial processes is a central challenge to industrial M&V, posing risk to the accurate determination of energy savings from EEMs. The remaining nine per cent of energy savings potential is from “operational and procedural” (O&M). While energy savings from O&M measures are proportionally small, their role is vital to overall system performance as well as providing an opportunity to reduce operating costs for industrial firms who are capital constrained. Like process improvements, O&M measures have wide ranging baseline characteristics, presenting a risk to the accurate determination of energy savings from EEMs.

4.6.4 BC Lack of Performance Feedback

Unfortunately there is no direct data available on the penetration of energy performance tracking systems or energy management information systems in the BC large industrial sector. However, indirect evidence suggests that, for many large energy intensive industrial facilities in BC, energy performance tracking is a low priority. This low priority has been attributed to lack of management buy-in and internal resource constraints (BC Hydro, August 3rd 2011).

As an example, according to the Canadian Mining Association's 2011 Towards Sustainable Mining Report, Teck Resources, the largest mining company in BC, scored an average of 1.8/5 for "Energy Use Management Systems" across all seven of their BC operations (MAC 2011). The indicator is designed "to confirm that systems are in place to manage energy use" (Ibid.). A similar indicator is the low level of participation in recent Natural Resources Canada (NRCan) energy management information system workshops ("Dollars and Sense") held in the province. The workshops provide information and training on implementing performance tracking systems and applying energy management techniques for large non-residential consumers. From 2011 to 2013, two workshops were held in Vancouver which together had a total of 5 industrial participants out of 29 total participants (NRCan 2012).

As another indicator, BC Hydro's Monitoring, Targeting and Reporting (MT&R) program has been virtually unsubscribed by industrial customers since its inception. MT&R offers incentives to develop performance tracking systems incorporating a continuous energy improvement methodology. In MT&R, industrial firms analyze data from performance tracking systems to identify periods of exceptional performance or poor performance. The firms then identify operating practices that resulted in either outcome, periodically set energy saving targets based on exceptional performance periods and continuously track data for variances between actual performance and targeted performance (Wallace and Greenwald 2007). Despite BC Hydro offering incentives to industrial customers that cover up to the full cost of MT&R system development, there has been no uptake of the program since 2008. The reasons for MT&R's undersubscription have been reported as lack of industrial firm management buy-in and support, internal resource constraints, lack of MT&R vendor expertise in the industrial market and the fact that MT&R offers a customized solution for customers that is difficult to market as a DSM program (BC Hydro, August 3rd 2011).[48]

4.7 Conclusion: BC Industrial DSM Incentive Program Risk Factor Profile

The objective of DSM resource acquisition programs is to cost-effectively and reliably obtain planned energy savings. DSM risk is thus defined as uncertainties that affect the cost-effective acquisition of planned energy savings from DSM measures. For industrial DSM incentive programs, DSM risk can be broken down into project development and project performance risks (Goldman and Kito 1995). Development risk represents the project ramp-up phase and is the risk that planned energy savings do not materialize due to low customer response to program incentives or that projects are not implemented successfully in customer facilities (Ibid.). Performance risk represents the operational phase and is the risk that planned energy savings do not persist over the effective measure life (Ibid.) DSM project development and performance risks are, in turn, a result of industrial economic, technological and organizational conditions, or DSM risk factors. These risk factors, identified generally in the industrial sector and specifically

[48] I address these challenges further and offer possible solutions in section 7.2.2.

in BC, form a DSM risk factor profile for the large industrial sector in BC (Table 11). In the following chapter detailing research methods, the risk factor profile and risk management options reviewed in this chapter are used to develop risk management criteria to assess the four performance incentive programs in this study.

Table 10. BC Large Industrial DSM Incentive Program Risk Profile

Constraints to energy efficiency investment	Given the volatile global commodity market conditions affecting the BC large industrial sector, notably with the pulp & paper and mining subsectors at the low and high end of their business cycles respectively, BC Hydro PSP-T customers with large energy saving potential are faced with substantial constraints to investment in EEMs. These constraints primarily include (a) lack of capital accessibility (scarce upfront capital), (b) lack of capital availability (EEMs not a strategic priority), (c) low credit ratings, and (d) limited internal resources to implement EEMs. General constraints to energy efficiency investment include limited timeframes within which EEMs can be implemented due to operational cycles.
Sector financial instability	The BC large industrial sector is sensitive to boom and bust commodity cycles and therefore experiences financial instability that increases the risk of stranded EEM assets in the event that industrial firms substantially change their operations or go bankrupt.
Potential for free riders	Large industrial firms are sophisticated energy users - while industrial firms implement a range of custom EEMs in spite of program influence, there is evidence that there are numerous cost-effective EEM opportunities that they do not adopt without program support.
Variable load, process-based energy saving potential	Determining baseline energy demand in variable load conditions is complex, resource intensive and poses a risk to the accuracy of energy savings. Process systems pose challenges to measuring hard to isolate EEMs.
Lack of energy performance feedback	While many industrial firms have planning and control systems capable of monitoring energy use, they frequently do not integrate energy efficiency as a relevant performance criterion. Without energy performance feedback, a firm's capacity to detect poor performance as well as optimize and maintain equipment and systems is diminished and the persistence of EEMs is at risk.

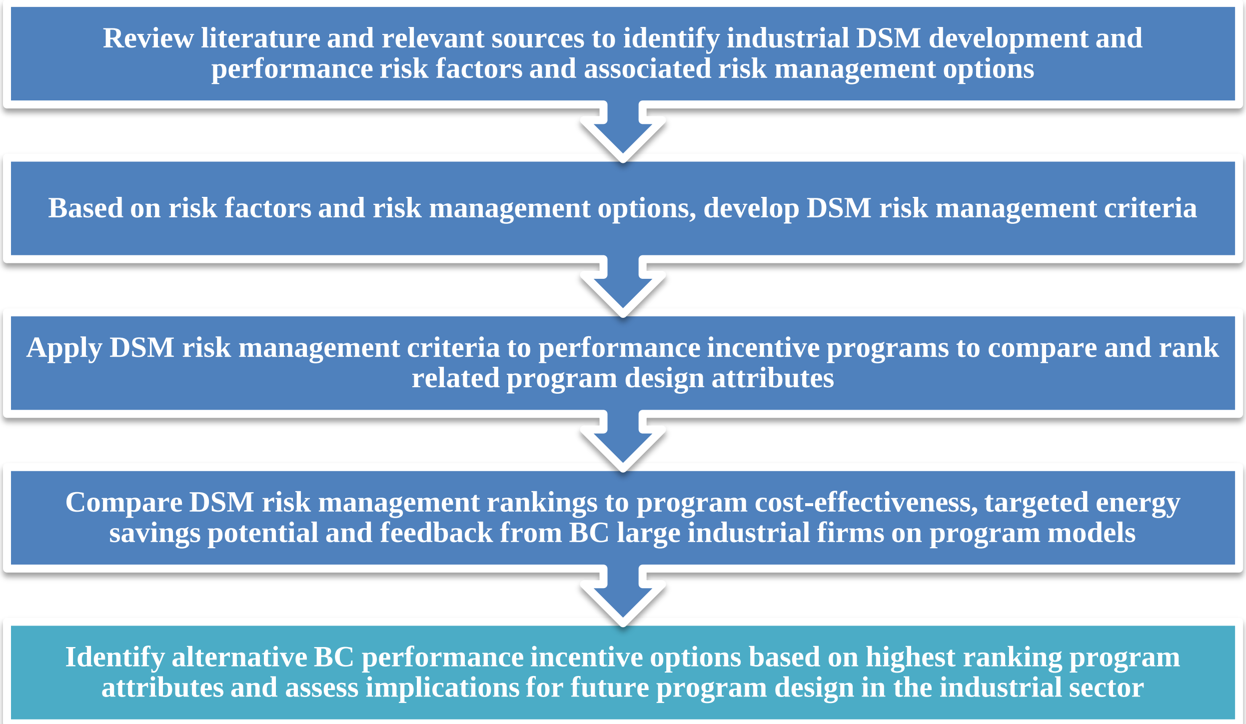
5 Methods

This study employs an applied policy research methodology, having the dual objective of synthesizing knowledge within the interdisciplinary domain of sustainable energy policy research and applying that knowledge to a case study of BC Hydro large industrial DSM program design. As detailed in Table 12, a five-stage process was used to assess the applicability and potential effectiveness of the selected performance incentive program models to manage DSM risk, and thereby maximize planned energy savings reliability in BC.

5.1 Methods Overview

The DSM literature and relevant sources were first reviewed to identify industrial DSM program risk factors both general to the large industrial sector and specific to BC (summarized in Table 11) as well as program design options for managing DSM risk. Based on the latter, DSM risk management criteria are developed (Tables 13 and 14). The criteria indicate the degree to which program attributes in each performance incentive program model have the capacity to manage DSM risks identified in BC. The criteria are then applied to the performance incentive program models to rank related program design attributes. DSM risk management rankings are then compared to program cost-effectiveness, targeted energy savings potential and feedback from BC large industrial firms on the program models. The implications of adapting performance incentive program models to BC (beyond BC Hydro's PSP-T Project Incentives) are then considered, followed by the identification of alternative BC performance incentive program design options for the BC large industrial sector. Finally, implications for large industrial DSM program design beyond BC are considered. DSM risk management criteria and their rationale are detailed in the remainder of this chapter.

Table 11. Performance Incentive Assessment Methodology



5.2 BC DSM Risk Management Criteria

Based on the BC industrial DSM incentive risk factor profile developed in chapter 4, DSM risk management criteria were developed in order to rank development and performance risk management strategies across the selected performance incentive program models. The criteria indicate the degree to which program attributes in each performance incentive program model have the capacity to manage DSM risks identified in BC. Criteria were equally weighted and program attributes were assigned a preference score from 0-4 using a relative scaling, direct rating approach. Recognizing the problem of direct program comparability given unique conditions and constraints in each jurisdiction, the evaluative risk management criteria were above all designed to allow for a BC- framed, detailed qualitative comparison of the trade-offs involved in each performance incentive program model.

5.2.1 DSM Development Risk Factors Addressed and Impacts Mitigated

Seven development risk management criteria were developed in relation to the development risk factors and management options reviewed in section 4.4. The criteria are described in Table 13 and summarized below. In total, they represent the capacity of the program models to effectively incent net participation while minimizing the impacts of project implementation delays or failures.

Table 12. DSM Development Risk Management Criteria

Development Risk Factors	Development Risk Management Criteria
Lack of capital accessibility (scarce upfront capital)	Percentage of incentive paid upfront
Lack of capital availability (EEMs not a strategic priority)	Percentage of overall project costs covered by incentive
Low industry credit ratings	Flexibility of creditworthiness requirement
Limited internal resources to implement EEMs	Implementation resources available
Constrained timeframes within which EEMs can be implemented	Years allowed for project development
Changing conditions or improper installation delays EEM beyond schedules	Contractual provisions for liquidated damages
Free riders	Incentive design or eligibility criteria to limit free riders

The degree to which capital accessibility and availability are addressed is indicated respectively by the percentage of total incentive paid upfront and percentage of project costs covered by the program. Upfront incentives minimize upfront costs that are otherwise prohibitive for firms with scarce capital. The greater the percentage of the EEM cost covered by the program, the more competitive the payback period is to firms in which energy efficiency is not a strategic priority. The extent to which low customer credit ratings are addressed is indicated by how stringent creditworthiness requirements are for each program. The degree to which programs address limited internal resources is indicated by their capacity to minimize participant staffing resources required to implement EEMs. The extent to which programs accommodate the longer timeframes required by industrial firms to plan and implement EEMs in indicated by the number of years allowed for project development. Contractual provisions for liquidated damages indicate the degree to which programs mitigate the impacts of potentially delayed or failed EEM implementation. Finally, the extent to which DSM administrators address free riders is indicated by incentive design (e.g. minimum payback floors or incentives based on incremental cost) or contractual mechanisms in place to minimize participants who would otherwise implement the EEM without an incentive.

5.2.2 DSM Performance Risk Factors Addressed and Impacts Mitigated

Five performance risk management criteria were developed in relation to the development risk factors and management options reviewed section 4.5. The criteria are described in Table 14 and summarized below. In sum, they represent the capacity of the program models to ensure the persistence of energy savings while transferring the risk of underperformance away from ratepayers.

Table 13. DSM Performance Risk Management Criteria

Performance Risk Factors	Performance Risk Management Criteria
Variable load, process-based energy saving potential	Degree to which incentives are paid for measured performance
	M&V rigour (IPMVP M&V Option A-C)
	Maximum contract length
Lack of energy performance feedback	Capacity of M&V approach to provide energy performance feedback to participant
Sector financial instability	Contractual measures to mitigate the risk of stranded utility investment

The degree to which incentives are paid for measured energy savings is a defining characteristic of the programs in this study and is a key criterion indicating the capacity of programs to incent persistent energy savings while transferring the risk of underperformance away from ratepayers. Given the difficulty of estimating energy savings in variable load conditions, the greater the percentage of incentives paid retroactively for measured savings, the less performance risk shouldered by ratepayers. Measures to mitigate the risk of stranded assets in the event of substantially changed customer operations or bankruptcy are indicated by contractual provisions such as security requirements. Maximum contract length reflects the degree to which participants are contractually responsible for the persistence of energy savings from EEMs within the effective measure life.

The rigour of M&V criteria indicates how applicable the M&V frameworks of each program model are to the variable load, process-based energy savings potential in the large industrial sector. As an indicator of rigour, the percentage of IPMVP options A, B or C respectively applied to EEMs in each program represents the degree to which energy parameters or key energy driving factors are measured or stipulated.[49] The greater the stipulation, the less applicable the M&V procedures are to the energy saving potential of the large industrial sector. Similarly, the greater the stipulation, the greater the performance risk shouldered by ratepayers as incentives are paid regardless if actual energy savings are less than estimated. As detailed in section 4.5.2, Option A and Option B represent a continuum of retrofit isolation M&V rigour. Option A frequently entails no measurement, with energy savings based on site inspections (verification) and engineering calculations alone. Option B involves measurements of multiple energy parameters (e.g. electrical load and operating hours) typically in the baseline and reporting period. Option C determines energy savings for EEMs at the meter or sub-meter level by analyzing the difference between measured energy use and baseline energy use. A number of energy driving factors are typically measured to adjust the baseline energy use model to reflect reporting period conditions. A greater percentage of Option A applied in M&V is thus associated with less rigorous M&V, while Options B and C are associated with greater rigour.[50]

Finally, while many industrial firms have planning and control systems capable of monitoring energy use, energy efficiency is frequently not included as a performance criterion. As noted, without energy performance feedback, a firm's operational capacity to detect poor performance as well as optimize and maintain equipment and systems is diminished and the persistence of EEMs is at risk. The "capacity to provide energy performance feedback to customer" criterion

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[49] Note, Option D is outside of the scope of this analysis as it generally applies to new or substantially modified facilities or sub-facilities where no meter exists to establish the baseline period.

[50] The rigour of M&V must also be considered in terms of the overall end-use mix of each program. EEMs with constant parameters like facility lighting or constant-speed motors require less intensive M&V procedures to ensure reliable energy savings. Assuming usage is predictable in the reporting period, Option A is a reasonable option for the latter. That said, as all of the programs being considered provided incentives for a variety of industrial end-uses, the ranking of M&V rigour is a reflection of the overall M&V ethos embedded in the program model.

indicates the ability of the program's measurement regime to support the persistence of energy savings from EEMs accordingly.

5.2.3 Program Cost-effectiveness

The total resource cost test (TRC) benefit-cost ratio and utility cost test (UCT) benefit-cost ratio were selected as indicators of cost-effectiveness and by extension, the resources required for each program model. The TRC benefit-cost ratio and UCT benefit-cost ratio are standard cost-effectiveness tests used by DSM administrators in North America to determine if, and by how much, the present value of benefits resulting from a DSM program are greater than the present value of costs over a specified time period. Both tests must result in a ratio greater than one to indicate cost-effectiveness (CPUC 2001).

Detailed below, the TRC benefit-cost ratio provides an overarching assessment of the resource's cost-effectiveness. Benefits include avoided primary and secondary supply costs resulting from net energy savings (i.e. net free riders) (CPUC 2001). Avoided primary supply costs are those associated with direct energy savings (e.g. electricity savings resulting from an electric utility DSM program). Avoided secondary supply costs are associated with indirect energy savings (e.g. if an electric utility DSM program also results in natural gas savings). Both of the latter are typically based on the long-run marginal cost of supply in the service area (U.S. EPA 2008). In some jurisdictions, DSM administrators will also include additional resource savings (e.g. water) as well as quantifiable non-energy benefits (e.g. increased reliability, safety, comfort) and environmental benefits (e.g. greenhouse gas reduction) (Neme and Kushler 2010). Costs in the TRC include program administration as well as measure costs (including financial incentives and customer contributions) (Ibid.).

Also detailed below, The UCT benefit-cost ratio indicates the resource's cost-effectiveness to the utility. As such, the benefits include only primary avoided supply costs resulting from net energy savings (Ibid.). Similarly, the costs include program administration in addition to program incentives, but exclude customer contributions.

The TRC benefit-cost ratio is calculated as follows:

$$\frac{\text{present value of avoided primary supply cost} + \text{avoided secondary supply cost}}{\text{present value of program administration costs} + \text{measure cost}}$$

The UCT benefit-cost ratio is calculated as follows:

$$\frac{\text{present value of primary avoided supply cost}}{\text{present value of program administration costs} + \text{incentives}}$$

While the TRC and UCT cost-benefit ratios provide a good measure of the cost-effectiveness for the respective performance incentive programs within their jurisdictions, they are ultimately intended to be a heuristic point of comparison in this study as the ratios are driven by a utility-specific set of assumptions including discount rate, incentive level (UCT), administrative costs, avoided cost of supply, effective measure life, measure mix, measure cost, net-to gross energy savings and other factors that could not be normalized for this study due to data availability and scope limitations. Likewise, the project sample sizes vary considerably for each program. TRC and UCT cost-benefit ratios included in this study were reported by PSE&G and NYSERDA in ex post evaluations, projected by BC Hydro in the latest PSP-T Business Case II and calculated for BPA based on costs to date and net energy savings estimates from recently completed projects.

5.3 Data Sources

Data on performance incentive programs was collected via analysis of utility filings, program manuals and evaluations, as well as semi-structured interviews of DSM program administrators. The interviews were conducted between March and October 2011 with program staff from NYSERDA, PSE&G, BPA and BC Hydro. Staff were asked to provide detail on the evolution of development and performance risk management strategies in the selected programs. Their responses were collated with published program data and scored in relation to the evaluative criteria. Additional data was collected via a survey of BC large industrial firms conducted from June to July 2011. The survey was designed to identify industrial conditions affecting participation in BC Hydro PSP-T Project Incentives and elicit feedback on the performance incentive program models. Energy management staff from four large industrial firms participated, representing pulp and paper, metal mining and coal mining industries. Although participants were asked to comment on conditions relating to BC Hydro PSP-T Project Incentives participation, the focus of the survey was primarily on the Track and Tune, Standard Offer and Existing Facilities models. The participants were given descriptions of each program model to consider as a hypothetical BC electric utility DSM offering. Participants were then asked to rate the prospective effort to benefit (i.e. internal resources required versus potential energy savings) for participating in each program as well as rate defining program attributes (e.g. performance tracking systems, long-term energy purchase agreement style contracts, energy service provider participants and utility financing). Due to the small number of firms surveyed, it was not possible to make statistical generalizations across the sector, but the results nevertheless illustrate a range of responses from a handful of the province's largest electricity consumers. A copy of the survey is included as an appendix A.

6 Results: Performance Incentive Program Model Assessment

DSM risk management criteria were developed in order to rank development and performance risk management strategies across the selected performance incentive programs with a BC-specific lens. Risk factors and management strategy are reviewed in section 4.4 and 4.5. The criteria that were developed from the review are detailed in section 5.2 and summarized in the left column of each table. The criteria indicate the degree to which program attributes in each performance incentive program model have the capacity to manage DSM risks identified in BC. Risk management criteria are equally weighted and assigned a preference score from 0-3 using a relative scaling, direct rating approach:

- [0] indicates the absence of a program attribute to address the DSM risk factor
- [1] indicates a program attribute that minimally addresses the DSM risk factor relative to the other program models
- [2] indicates a program attribute that moderately addresses the DSM risk factor relative to the other program models
- [3] indicates a program attribute that rigorously addresses the DSM risk factor relative to the other program models

Each column is footnoted to indicate the sources of program data that were evaluated. Ranking highlights are discussed below each column. DSM risk management rankings are then compared to program cost-effectiveness and targeted energy savings potential in BC. This is followed by a discussion detailing feedback from BC industrial firms on the program models.

6.1 Development Risk Management

Table 15 shows the degree to which programs manages project development risk by addressing customer barriers to energy efficiency investment, including contractual damage provisions and limiting free riders

Table 14. BC Development Risk Management

Risk Factor& Management Criteria	PSEG Standard Offer[51]	NYSERDA Existing Facilities[52]	BPA Track and Tune[53]	BCH PSP-T Project Incentive[54]
Capital constraints (% of total incentive paid upfront and % of project costs covered)	**No upfront incentive** provided by utility, however it is reported that ESCOs commonly covered upfront costs for customers: [1] **No % cap on project cost covered**: incentive payment up to 100% of projected avoided supply costs over 5,10,15 year contract term [3]	**60-100% of incentive paid upfront** upon verification of EEM installation [2] **Incentives are based on one year's energy savings from installed EEMs**; NYSERDA typically pays 18% of project costs [1]	**100% incentive for performance tracking system paid upfront** upon verification of installation**; sustained savings incentive paid annually for performance** [3] **Up to 100% of performance tracking system cost covered** for systems <$50,000; **No % cap on O&M costs covered**: sustained incentive over 3-5 year contract term [3]	**Up to 90% of the incentive paid during implementation** [3] Up to 100% of EEM cost covered for projects < $1 million **and up to 75% of EEM cost covered for projects >$1 million** [3]
Low customer credit rating (flexibility of creditworthiness requirement)	**No explicit creditworthiness requirement**: utility pays only for performance, though the majority of projects utilized third-party financing typically requiring creditworthiness	**Discretionary creditworthiness requirement**: [2]	**No explicit creditworthiness requirement** [3]	**Creditworthiness requirement for projects >$100,00**, however customers not meeting credit rating requirement can still be eligible for project incentives by posting a letter of credit [2]

[51] Goldman et al. 1995; The Results Center 1994; Kushler and Edgar 1999; PSE&G, July 13th 2011

[52] NYSERDA 2009; NYSERDA, March 4th 2011; NYSERDA, June 27th 2011

[53] BPA 2009; BPA, June 21st 2011

[54] BC Hydro 2009a; BC Hydro, August 3rd 2011

	[2]			
Limited internal customer resources to implement measures (implementation resources available)	**Program model predicated on energy efficiency service providers delivering turnkey services**; 82% of Standard Offer 1&2 program savings resulted from ESCO implemented projects [3]	**Program model predicated on energy efficiency service providers delivering turnkey services;** 85% of current participant are energy service providers [3]	**BPA affiliated energy efficiency service providers provide initial O&M scoping and tune-up and assist in implementation of performance tracking system [3]**	**BC Hydro helps arrange for affiliated energy efficiency service providers** [1]
Constrained project implementation timeframes (number of years allowed for project development)	**On average, projects took greater than 18 months to become operational in SO1** [3]	**Applicants have two years from date of preapproval to complete projects** [3]	**All current projects have taken two years to become operational [3]**	**Customers have 18 months to implement a project upon approved incentive** [2]
Changing conditions or improper installation delays EEM beyond schedules (provisions for liquidated damages)	**Participants required to establish liquidated damages fund** [3]	**No liquidated damages** [0]	**No liquidated damages** [0]	**Liquidated damages required** [3]
Free riders (incentive design or eligibility criteria or to limit free riders)	**No free-ridership measures** [0]	**Incentive provided only for incremental cost** [3]	**No free-ridership measures** [0]	**Customers are required to sign a declaration stating that they have not already engaged a contractor or purchased equipment to complete the energy efficiency project** [2]
Total	**15/21**	**14/21**	**15/21**	**16/21**

Overall development risk management scores were comparable across all programs, although program scores per criterion differed considerably. BPA's Track and Tune ranked highest in addressing constraints to EEM investment on account of its emphasis on low-cost O&M improvements that do not require capital or customer creditworthiness. The entire cost of the performance tracking system is paid upfront by the utility. BPA affiliated energy service providers perform the scoping, O&M tune-up and assist in the implementation of the performance tracking system. Participants receive a long-term incentive for sustained savings. In terms of programs supporting capital EEMs, BC Hydro's PSP-T Project Incentives and PSE&G's Standard Offer ranked highest. The substantial upfront incentives in PSP-T, and high overall incentive levels in both programs, were key attributes. In the case of the Standard Offer, it was reported that ESCOs would often cover upfront costs on projects they provided or arranged financing for. Another important criterion that applies to capital constraints is the availability of program related EEM financing. In the case of the Standard Offer, low-cost financing via the utility subsidiary, Public Service Conservation Resources Corporation, played a vital role in developing EEMs. As financing was not a program attribute per se, it was not included as a criterion.

While creditworthiness requirements are a barrier to EEM investment and program participation for firms with low credit ratings, the criterion is not intended to reflect negatively on those programs that have such provisions. Creditworthiness requirements are a risk management strategy. It is notable, however, that program models where incentives are paid for ex post energy savings avoid having to erect this gate without increasing their risk exposure.

In terms of addressing limited internal resources, the Standard Offer and Existing Facilities programs scored high on account of their inclusion of energy service providers as eligible participants. Both programs are predicated on the capacity of ESCOs, vendors and engineering firms to provide turnkey EEMs for customers.

With the exception of PSP-T Project Incentives, all of the programs had a minimum of two years or relatively flexible lead times for project development. While flexibility helps accommodate the longer timeframes required by industrial firms to plan and implement EEMs - and is thus effective in helping to incent participation - ensuring project development in accordance with schedules is also key in managing development risk. Notably only the Standard Offer and PSP-T Project incentives included contractual provisions for liquidated damages that require compensation to the utility if EEMs are delayed or fail to develop.

Finally, only Existing Facilities and PSP-T Project Incentives included program attributes to minimize free riders. NYSERDA pays incentive based exclusively on incremental costs and BC Hydro requires participants to sign a declaration stating that they have not already engaged a contractor or purchased equipment related to the EEM.

6.2 Performance Risk Management

Table 16 shows the degree to which programs manages project performance risk through incentive design, contractual measures, M&V methods and energy performance feedback provisions.

Table 15. BC Performance Risk Management

Risk Factor &Management Criteria	PSEG Standard Offer[55]	NYSERDA Existing Facilities[56]	BPA Track and Tune[57]	BCH PSP-T Project Incentive[58]
Variable load, process-based energy saving potential (degree to which incentives are paid for measured performance)	**High**: 100% of projects receive Incentives paid only for ex post energy savings [3]	**Low:** 90% of projects receive total incentive upfront based on estimated savings; remaining projects receive 60% of incentive upfront, with option to pro-	**High:** 100% of "Sustained Savings" incentives paid for ex post energy savings [3]	**Medium:** 100% of projects receive 90% of incentive during implementation with option to pro-rate balance or require reimbursement following one year of continuous post-retrofit M&V [2]

[55] Goldman et al. 1995; The Results Center 1994; Kushler and Edgar 1999; PSE&G, July 13th 2011

[56] NYSERDA 2009; NYSERDA, March 4th 2011; NYSERDA, June 27th 2011

[57] BPA 2009; BPA, June 21st 2011

[58] BC Hydro 2009a; BC Hydro, August 3rd 2011

		rate balance or require reimbursement following one year or less of post-retrofit M&V [1]		
Variable load, process-based energy saving potential (M&V rigour: IPMVP M&V Option A-C)	**High**: Options B, C equivalent applied to 100% of projects; All projects require continuous, long-term M&V [3]	**Low**: Option A applied to 90% of projects; majority of projects require only engineering analysis, pre and post inspection [1]	**High**: Option B, C applied to 100% of projects; program requires the implementation of a performance tracking system to M&V O&M savings [3]	**High**: Option B applied to 100% of projects; All projects receive up to one year of continuous post-retrofit M&V [3]
Variable load, process-based energy saving potential (maximum contract length)	15 years [3]	2 years [2]	3-5 years [3]	15 months [1]
Lack of energy performance feedback (capacity to provide energy performance feedback)	**Medium**: long-term measurement of EEMs may provide a continuous feedback mechanism for energy use [2]	**Low:** low overall, but Monitoring-Based Commissioning incentives, a fraction of the program to date, strive for this goal [1]	**High**: performance tracking system stays in place to allow customers to monitor energy performance and report O&M energy savings [3]	**Low:** M&V does not provide a long-term, continuous feedback mechanism for energy use [1]
Sector financial instability (contractual measures to mitigate the risk of stranded utility investment)	Participants required to submit security with all project proposals [3]	No security required [0]	No security required [0]	Letter of credit required for incentives > $ 1 million to secure investment [2]
Total	**14/15**	**5/15**	**12/15**	**9/15**

Overall performance risk management scores were distributed widely. PSE&G's Standard Offer ranked highest at managing performance risk on account of paying incentives only for ex post energy savings, requiring security for all projects, and perhaps most remarkable, having long-term contracts up to 15 years in duration. The Standard Offer's long-term contracts were intended to mirror energy purchase agreements made with independent power producers at the time. The long-term contract, coupled with monthly incentives, enabled the utility to ensure the persistence of energy savings with continuous M&V over the effective measure life of the EEMs.

NYSERDA's Existing Facilities ranked lowest in performance risk management. The most notable factor in its low score was its record of paying total incentives upfront to 90 per cent of projects based exclusively on engineering estimates of energy savings. The remaining ten per cent of projects received 60 per cent of the incentive upfront, with the balance received following a year or less of post-retrofit M&V.

The highest scores in the "degree to which incentives are paid for measured performance" category were assigned to programs for paying all of their incentives based on ex post energy savings, for example the Standard Offer and Track and Tune. PSP-T Project Incentives received the next highest scores given that, in spite of paying a substantial portion of the incentive upfront, the program required rigorous M&V and maintained the option of prorating the balance of the incentive or requiring reimbursement. While both approaches represent rigorous methods that transfer performance risk to participants, the former method ensures that funds strictly pay for measured savings. That said, the certainty gained from paying incentives exclusively for ex post energy savings comes at the expense of not addressing upfront capital barriers. In this respect, the degree to which incentives are paid for measured performance criterion and the percentage of incentive paid upfront criterion are inversely related.

The Standard Offer, Track and Tune and PSP-T Project Incentives tied for M&V rigour. All three programs require continuous post-retrofit measurement for EEMs comparable to IPMVP options B or C. In terms of performance feedback, Track and Tune was exceptional in providing performance tracking systems capable of measuring energy savings from EEMs as well as providing real-time performance feedback to participants to support the persistence of EEMs. The Standard Offer arguably provided some degree of performance feedback on EEMs due to the long-term, continuous nature of M&V.

Finally, only the Standard Offer and PSP-T Project Incentives require security from participants to provide compensation to the utility in the event that energy savings deteriorate due to substantially changed operations or bankruptcy.

6.3 Program Cost-effectiveness

The total resource cost test (TRC) benefit-cost ratio and utility cost test (UCT) benefit-cost ratio were selected as indicators of cost-effectiveness and by extension, the resources required for each program. Table 17 shows program cost-effectiveness, along with net annual energy savings, program costs and staffing estimates for overall comparison.

Table 16. Program Cost-effectiveness

Program Cost-Effectiveness	PSEG Standard Offer[59]	NYSERDA Existing Facilities[60]	BPA Track and Tune[61]	BCH PSP-T Project Incentive[62]
Program data	1993-1997	July 2006-December 2009	November 2009 - June 2011	January 2010-June 2011
TRC B-C Ratio	1.38	1.5	~2.57	~2.6
UCT B-C Ratio	n/a	8.6	~3.17	~4.0
Discount rate (weighted average cost of capital)	11.2%	5.5%	5%	6%

[59] Goldman et al. 1995; Kushler and Edgar 1999; PSE&G, July 13th 2011

[60] NYSERDA 2010; NYSERDA, March 4th 2011; NYSERDA, June 27th 2011

[61] BPA, June 24th 2011

[62] BC Hydro 2009a; BC Hydro, August 3rd 2011

Average effective measure life	10 years	15 years	8-10 years	11 years
Net annual energy savings (run rate)	1,100 GWh	558.3 GWh	~9.2 GWh*	~107 GWh (with an additional 101.8 GWh in committed projects)*
Program cost (constant 2011 dollars)	$325 million	$77 million	$326,659 to date	$7.6 million to date (with an additional $18.6M in committed projects)
Full-time equivalents	30	12	1.75	29.12

* This figure represents estimated net energy savings

BC Hydro PSP-T Project Incentives and BPA Track and Tune are projected to have the greatest total resource cost-effectiveness compared to reported values from NYSERDA Existing Facilities and the PSE&G Standard Offer. Notably, PSE&G's higher discount rate has the effect of lowering the Standard Offer's cost-effectiveness. In contrast, Existing Facilities utility cost-effectiveness is highest.[63] Customer co-funding for EEMs implemented under Existing Facilities were 85 per cent of total project costs which is likely the greatest factor driving the high UCT benefit-cost ratio. A UCT benefit-cost ratio was not available for the Standard Offer, however, incentives accounted for approximately eighty to ninety per cent of total project costs, so the UCT ratio would be relatively similar to the TRC ratio, and low compared to the other programs. While the percentage of EEM costs covered by a utility drives the UCT benefit-cost ratio, it does not drive the TRC benefit-cost ratio which takes in to account the total measure costs regardless of who pays. As detailed in this section 4.4.3, incentive levels play a key role in minimizing capital constraints. In this respect, the UCT benefit-cost ratio is the most appropriate metric to consider in terms of resources required for each program model. However, as incentive levels

[63] EEM costs typically occur upfront and energy savings occur over time so the higher the discount rate the less cost-effective the program.

vary in each program, the TRC benefit-cost ratio provides the most universal point of comparison for cost-effectiveness between the programs.

6.4 Risk Management Ranking, Cost-effectiveness and Targeted Energy Savings Potential

Table 18 shows the BC DSM risk management ranking of the four performance incentive programs considered in this study. The rankings are cross-referenced with the TRC and UCT cost-benefit ratios, as well as targeted energy savings potential. The targeted achievable energy savings potential of each program model was extrapolated from the latest Conservation Potential Review data available for the transmission service sector from BC Hydro (see section 4.6.3) and represents a two year period from 2009-2011. The percentage of potential energy savings allocated to each program was based on measure eligibility. Figures for the Standard Offer, Exiting Facilities and Project Incentives reflect hard-wired, capital EEM energy savings potential; Track and Tune reflects O&M energy savings potential.

Table 17. Ranking Summary, Cost-effectiveness and Targeted Energy Savings Potential

Criteria ranking, cost-effectiveness and targeted potential	PSE&G Standard Offer	NYSERDA Existing Facilities	BPA Track and Tune	BC Hydro PSP-T Project Incentive
Development Risk Management	15/21 [71%]	14/21 [67%]	15/21 [71%]	16/21 [76%]
Performance Risk Management	14/15 [93%]	5/15 [33%]	12/15 [80%]	9/15 [60%]
Ranking	**80%**	**53%**	**75%**	**69%**
TRC B-C Ratio	1.38	1.5	~2.57	~2.6
UCT B-C Ratio	n/a	8.6	~3.17	~4.0

Per cent of BC achievable savings potential targeted 2009-2011[64]	678 GWh [91%]	678 GWh [91%]	70 GWh [9%]	678 GWh [91%]

6.5 BC Large Industrial Firm Response to Performance Incentive Models

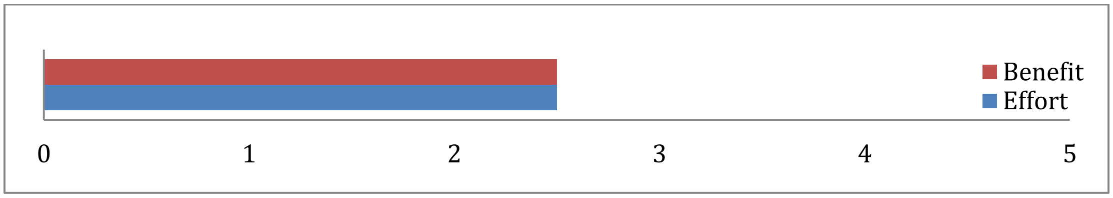
A web survey of BC large industrial customers was conducted to identify conditions affecting BC Hydro PSP-T Project Incentives and elicit responses to the program models (see Appendix A). Solicitations were forwarded to members of the Association of Major Power Consumers (AMPC) as well as the Mining Association of BC (MABC). Management staff from four large industrial firms participated, representing pulp and paper, metal mining and coal mining industries. Although participants were asked to comment on conditions relating to BC Hydro PSP-T Project Incentives participation, the focus of the survey was primarily on the Track and Tune, Standard Offer and Existing Facilities models. The participants were given descriptions of each program model to consider as a hypothetical BC electric utility DSM offering. Participants were then asked to rate the prospective effort to benefit (i.e. internal resources required versus potential energy savings) for participating in each program as well as rate defining program attributes (e.g. performance tracking systems, long-term energy purchase agreement style contracts, energy service provider participants and utility financing). Due to the small number of firms surveyed, it is not possible to make any statistical generalizations across the sector, but the results nevertheless articulate a range of responses from a handful of the province's largest electricity consumers.

Figure 6 illustrates the overall rating of effort to benefit for each program model. The Track and Tune program model was rated as both requiring the greatest effort and providing the greatest

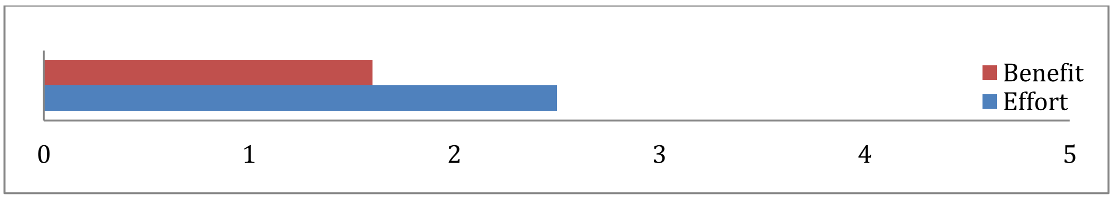
[64] BC Hydro 2009a

benefit, followed by the Standard Offer which was rated as requiring less effort and providing proportionally less benefit, and finally, Existing Facilities which was rated as requiring comparable effort to the Standard Offer, but providing less benefit.

Standard Offer



Existing Facilities



Track and Tune

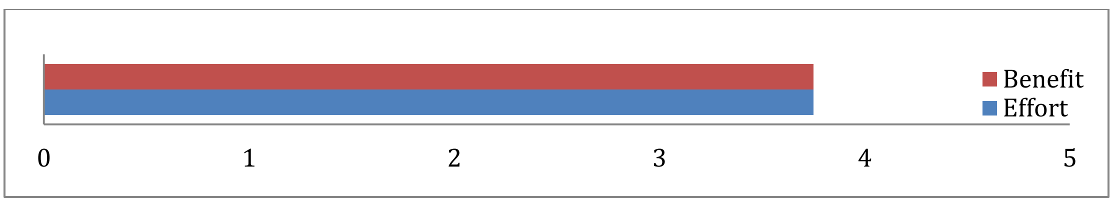


Figure 6. BC Industry Responses to Program Models

Referring to the Track and Tune program model, one pulp and paper manager noted that “the benefits would likely reach into other parts of the business in addition to strictly energy consumption.” Though recognition of program benefits was not universal, for example a manager in the mining sector noted: “Hard wired projects deliver savings once implemented with little support. Track and Tune seems more behavioural and ongoing effort will be great. Mining seems more set up for big impact projects versus a lot of small changes in the control of the operator/maintenance.” Further to the last point, the firms were asked to rate interest in a modified Track and Tune offering that included capital and O&M EEMs. The responses were evenly distributed between low, medium and high. Even though the Track and Tune model ranked highest in prospective benefits, responses to the actual performance tracking system itself were mixed, with one pulp and paper manager noting, “the upfront work for the system is expensive and the benefits are intangible so it would be difficult to justify.” Asked to indicate the preference for M&V via the current BC Hydro approach or via a performance tracking system, the response was evenly split.

The participating firms rated their interest as low to moderate for the Standard Offer’s long-term energy purchase agreement-style contracts, with a manager from a coal mining firm noting, “[it is] easier to get one upfront incentive to implement, rather than having to do long-term planning and justification of a project.” A pulp and paper manager cited pressure to his sector and resulting enterprise risk as being a factor in low interest.

Asked to rate interest in an Existing Facilities model program where energy service providers receive utility incentives to provide turnkey energy efficiency services to customers (identify, arrange financing if necessary and implement EEMs), two participants responded with low interest and a third rated interest as moderate. A manager at a pulp and paper firm noted that there would be sector-wide appeal in working with equipment vendors who bundle incentives with cross-cutting technologies (e.g. motors, drives, air compressors, pumps, etc.).

There was moderate recognition of the benefits of utility financing by participating firms. The potential complexity of repayment, compared to the straightforward nature of capital incentives, was cited as a disadvantage. Notably, three of the participants responded that lack of access to suitable financing for EEMs was a not a factor limiting investment in energy efficiency for their firms. Those same firms cited cash, general lines of credit and BC Hydro incentives as being typical financing methods used for EEMs.

7 Discussion: Analysis and Alternative Program Design

7.1 Introduction

In this chapter, program results are first considered at a high level in terms of the trade-off between risk management ranking, cost effectiveness and targeted savings. The relationship between development risk and performance risk management strategies in each model is then assessed, followed by a consideration of DSM risk allocation. Next, the applicability of each program model to BC is evaluated and lessons learned are detailed. Alternative performance incentive program models synthesizing the highest-ranking program attributes are then identified. The chapter concludes with a discussion of how alternative performance incentive program models could be applied to BC

7.2 DSM Risk Management Ranking, Cost-effectiveness and Targeted Energy Savings Potential

Of the programs considered, the DSM risk management criteria analysis indicates the Standard Offer and Track and Tune performance incentive models offer the greatest potential to effectively manage DSM risk in BC and thus result in reliable energy savings. However, this potential comes at a cost in terms of limited energy savings potential in the case of Track and Tune which focuses exclusively on O&M measures and at a cost premium in the case of the Standard Offer.[65] The PSP-T Project Incentive

[65] Note, the high discount rate applied in the Standard Offer calculation partly accounts for its lower cost-effectiveness compared to the other program models. EEM costs typically occur upfront and energy savings occur over time so the higher the discount rate the less cost-effective the program. Unfortunately the discount rate could not be normalized as Standard Offer program data was not available. That said, given the program's incentives were up to the full avoided cost of supply for up to 15 years, and the requirement for continuous M&V over that period, it is clear that the program was costly compared to third and fourth generation performance incentive programs.

program strikes a balance, placing highest in total resource cost-effectiveness and ranking in the middle of risk management performance. Figure 7 illustrates the trade-off between cost-effectiveness, risk management and targeted saving potential in each model.

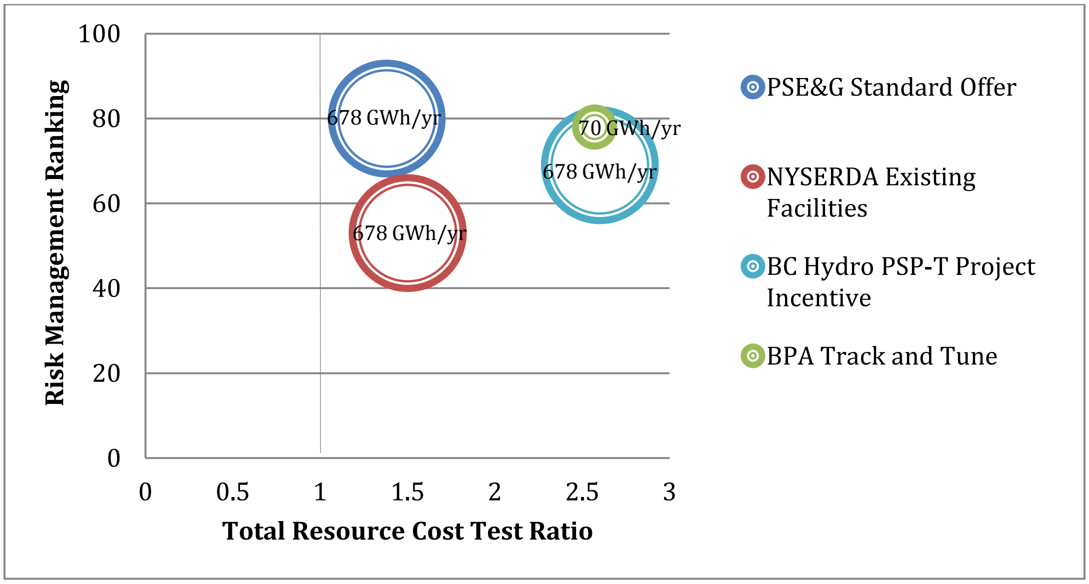


Figure 7. DSM Risk Management Ranking, Cost-effectiveness and Targeted Energy Savings Potential

7.3 DSM Performance Risk vs. DSM Development Risk

Figure 8 plots the performance risk management ranking against the development risk ranking of each program model, illustrating the balance each program struck between maximizing net participation and ensuring the persistence of energy savings. This balance is in part a function of development and performance risk management attributes that are inversely related. For example, it is argued that ex post incentives result in the greatest project performance as program funds are paid strictly for measured energy savings. However, the lack of upfront incentives comes at the expense of not addressing capital barriers for industrial firms that can limit project development. Likewise, creditworthy requirement create barriers to participation for industrial firms who are struggling with low credit ratings. However, creditworthiness requirements also help to ensure that energy savings will remain persistent.

While the above development and performance risk management *attributes* are inversely related in principle, in sum, the results indicate that development risk management and performance risk management *strategies* need not necessarily be inversely related. As a case in point, performance risk management rankings skewed widely but overall development risk management scores were comparable across all programs. Looking closely at the development risk results reveals that each program managed the trade-off in development and performance through compensating program attributes. The Standard Offer, for example, puts an emphasis on third-party financing and project implementation to help participants overcome the lack of upfront incentives. The Standard Offer also has no creditworthiness requirements, but ensures performance by only paying for ex post energy savings. The PSP-T Project Incentive program streamlines the incentive process by offering a large portion of the incentive upfront, but maintains significant contractual provisions to ensure project development. Track and Tune provides incentives upfront for the implementation of the performance tracking system but requires that performance incentives be based on measured performance. Notably, Existing Facilities does not have any compensating attributes, leaning clearly towards development objectives at the cost of increasing performance risk (i.e. incentives are paid up front, no creditworthiness requirements and minimal M&V requirements).

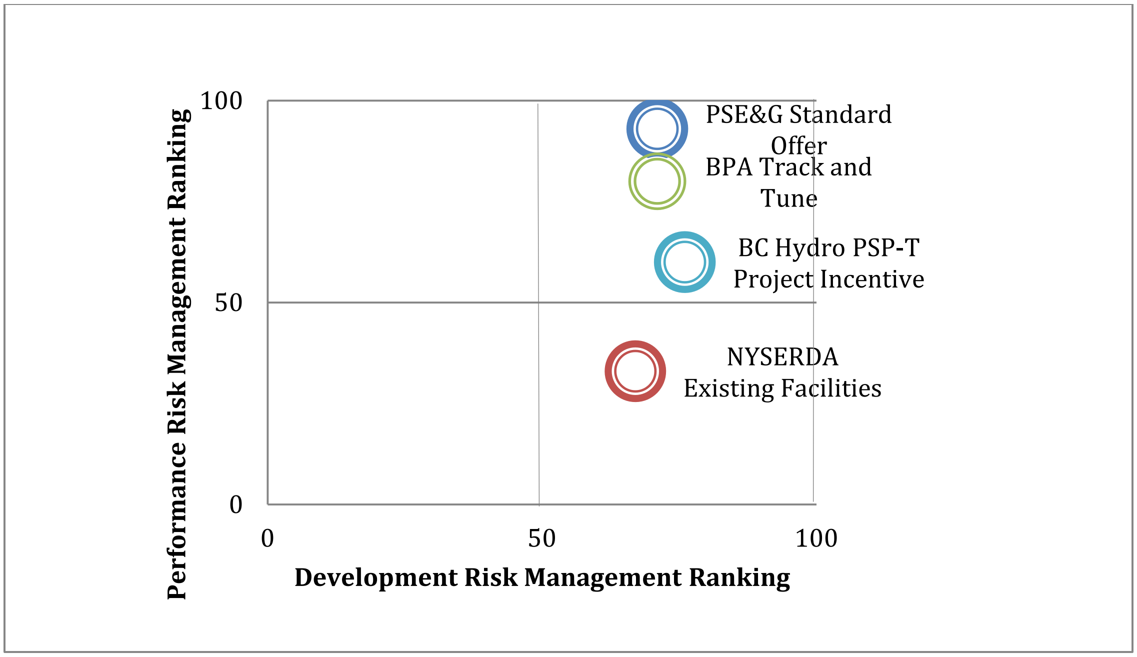


Figure 8. DSM Performance vs. DSM Development Risk Management

7.4 Allocation of DSM Risk

While addressing risk factors is one component of risk management, another is mitigating risk impacts. To varying degree, all of the programs in this study mitigate the risk of EEM underperformance (including failure to develop due to poor market uptake) at the program level by transferring the consequences to participants. Accordingly, figure 9 shows the allocation of risk between ratepayers and participants.[66] Risk transfer was achieved by contractual provisions for liquated damages and security requirements in the Standard Offer and PSP-T Project Incentives that provide financial compensation in the event of project failure. Similarly, an incentive design based exclusively on measured

[66] Risk allocation was based on ranking in the following criteria: (1) Degree to which incentives are paid for measured performance; (2) contractual measures to mitigate the risk of stranded utility investment; (3) maximum contract length.

energy savings in the Standard Offer and Track and Tune ensures the ratepayers pay only for real energy savings. As well, longer contract terms in the Standard Offer and Track and Tune ensure ratepayers pay only for persistent energy savings. That said, longer-term program models can involve greater overall program costs and be problematic in terms of regulatory and budget uncertainty and commodity cycles of industrial economies. Maximum contract lengths across the other programs averaged two years, which reflects a utility strategy to balance cost and risk. However, given that the effective measure life of many EEMs extends well beyond the incentive contracts - 11.25 year average across all of the programs - ratepayers assume post-contract performance risk for those measures in proportion to the percentage of project cost covered by the incentive. BPA's Track and Tunes strikes a balance, with a maximum contract length of five years.

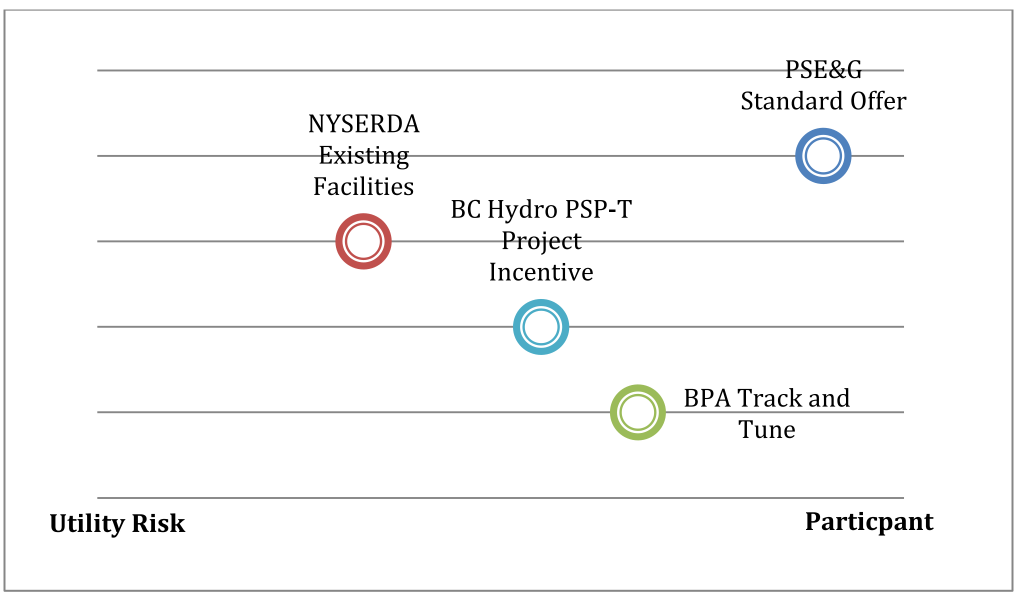


Figure 9. Allocation of DSM Risk

7.5 Model Analysis & Application in BC

Lessons learned from each program model are discussed below as they relate to BC. Highest scoring program attributes and feedback from industrial firms are highlighted. The models are presented in order of DSM risk management ranking; BC Hydro PSP-Project Incentives are considered last in relation to the other program models.

7.5.1 PSE&G Standard Offer

The Standard Offer model ranked highest in the DSM risk management criteria analysis on account of offering a comprehensive and long-term incentive that both addressed customer constraints to investment in energy efficiency and provided the utility with substantial safeguards in the event of EEM underperformance. The highest scoring attribute of the program was its long-term contracts and M&V requirements intended to mirror energy purchase agreements made with independent power producers (Results Center 1994; Goldman et al. 1995). Up to fifteen year contracts and monthly incentives enabled the utility to ensure the persistence of energy savings with continuous M&V over the effective measure life of the EEMs. However, as noted, the long-term contracts came at a substantial cost over time for PSE&G. Part of this costliness was due to the uncertainty of forecasted avoided costs (PSE&G, July 13th 2011). The utility set a schedule of prices for energy savings for the full length of the contract at the time of project approval. The schedule reflected PSE&G’s forecast of avoided supply cost for up to fifteen years based on assumptions of energy cost escalation and inflation. The contract committed the utility to these assumptions and corresponding payments (Ibid.). While evaluations of Standard Offer 1 and 2 found the program to be cost-effective according to the total resource cost test in 1997 (1.38), there have been no further public evaluations of the program to determine ex post cost-effectiveness over the course of fifteen years (Kushler and Edgar 1999).

Since the Standard Offer DSM program administrators have moved away from performance incentive program designs that involve long-term contracts in favour of shorter-term time frames that align with expenditure cycles and provide maximum flexibility to adjust incentives (Goldman et al. 1998; CBP 2004). BC Hydro's PSP-T Project Incentive program certainly conforms to that trend. As such, adopting long-term contracts would be a substantial departure from current program design in BC. From the industrial perspective, as indicated in the results section, survey respondents rated their interest as low to moderate for the Standard Offer's long-term energy purchase agreement-style contracts (Performance Incentive Web Survey 2012). One mining firm noted their preference for upfront incentives given the long-term planning they perceived would be required for longer –term requirements (Ibid.). A pulp and paper manager cited pressure to his sector and resulting enterprise risk as being a factor in low interest (Ibid.). All of that said, paying incentives exclusively for ex post energy savings over a medium length contract (e.g. two to five years) would offer BC Hydro the benefit of ensuring the persistence of energy savings closer to the average measure life of most EEMs (as opposed to the 15 month contract currently used).

7.5.2 BPA Track and Tune

The Track and Tune model ranked second highest in the DSM risk management criteria analysis on account of offering an incentive for ex post energy savings resulting from low-cost O&M improvements and providing resources to implement a performance tracking system. The performance tracking system serves the dual function of providing performance feedback and M&V. Track and Tune is unique in providing direct incentives for O&M savings, transforming a less defined source of energy savings into a measurable resource. At the same time, providing an incentive that is directly connected to tangible O&M actions motivates participating firms to maintain improved O&M procedures. O&M improvements also provide a relatively inexpensive means for industrial firms faced with capital barriers to secure energy savings.

Performance tracking systems are not a unique attribute of the Track and Tune program. Energy management systems with similar characteristics have been incorporated, for example, in continuous building commissioning programs and building occupant engagement initiatives (Pape-Salmon and Ross 2010).[67] Developing the methods, expertise and customer buy-in to implement custom performance tracking system for industrial operations is, however, a novel adaptation of the continuous commissioning DSM program model to the industrial sector.

As noted, a limitation of the Track and Tune program model is its exclusive application to O&M energy savings potential. However, the choice to focus on O&M measures is not an inherent limitation of the Track and Tune program model. The performance tracking system, which in essence is a customer feedback-enabled, sustained application of IPMVP Option C, is also capable of measuring energy savings from hard-wired capital projects. A program administrator from BPA noted that including capital projects was technically feasible and a possible future direction for that program (BPA, October 25th,

[67] For example, BC Hydro's Continuous Optimization program for commercial buildings

2011). The performance tracking system offers an opportunity for a rigorous, streamlined and auditable M&V platform applicable to a broad range of EEMs.

A challenge to applying the Track and Tune model to BC, and in general, is the upfront resources required for the robust development of performance tracking systems (as well as their periodic adjustment to account for non-routine changes to facilities, production or processes). Tracking systems will require the development of in-house, utility and energy service provider expertise to be deployed and maintained at scale in BC. However, while the performance tracking system is resource intensive, it can accommodate multiple EEMs at customer sites over time, allowing for greater returns on M&V resources invested than current project-based M&V approaches. Notably, half of the industrial survey respondents indicated their preference for M&V via a performance tracking system over the current BC Hydro project-based approach (Performance Incentive Web Survey 2012).

Another challenge in BC is getting industrial management buy-in, given the relative novelty of the systems and the cited perception of intangible benefits by some BC industrial firms (Performance Incentive Web Survey 2012). Future research is required to determine how and why industrial firms participating in BPA's Track and Tune program found performance tracking systems to be a beneficial attribute. Nonetheless, tying a sustained incentive opportunity for O&M and capital projects to the performance tracking system may offer a step in the direction of making benefits more concrete.

Beyond the immediate benefits of offering energy performance feedback to industrial customers, a longer-term incentive to implement a performance tracking system could be linked to BC Hydro's Monitoring, Tracking and Reporting program. MT&R applies a continuous improvement methodology to a comparable system and has been undersubscribed to date (see section 4.6.4). Likewise, the performance tracking system could function as a foundation for similar continuous improvement energy management frameworks such as *the ISO 50001 Energy management system standard*. Both of these approaches would be consistent with BPA's strategy of making Track and Tune the foundation of their energy management portfolio (BPA 2009).

Finally, while the performance tracking system would offer BC Hydro an opportunity to understand customer energy use patterns and identify other EEM opportunities, limits to data access would likely need to be established and promoted upfront to allay industrial firm concerns over privacy and system security in general.

7.5.3 NYSERDA Existing Facilities

While the Existing Facilities model ranked close to the other models in development risk management on account of paying 60-100% of incentive paid upfront, it scored lowest in performance risk management on account of providing those incentives to 90% of projects based exclusively on engineering estimates of energy savings. The remaining ten per cent of projects received 60 per cent of the incentive upfront, with the balance received following a year or less of post-retrofit M&V. As detailed in section 2.5, in the late 1990s Existing Facilities (then the Standard Performance Contract Program) built its credibility on extensive and rigorous M&V for most EEMs. NYSERDA has streamlined its approach over the years reflecting an effort to maintain participation rates as well as greater experience with common EEMs. For example in 2009, NYSERDA introduced MWh thresholds below which M&V was not required. These thresholds were initially applied exclusively to lighting measures and then recently, to all measures (NYSERDA, June 27th 2011). Currently, Existing Facilities requires M&V for lighting projects that provide annual energy savings greater than 1,000 MWh or non-lighting EEMs that provide annual energy savings greater than 500 MWh (NYSERDA 2009). For technologies requiring M&V, NYSERDA introduced sample M&V plans to reduce costs associated with custom plan development (Ibid.). In contrast to the other performance incentive programs considered in this study, Existing Facilities has come to resemble a custom incentive program in recent years. To some degree this is representative of the broad slice of large non-residential customers the program serves, many of whom require only common, building-oriented EEMs.

Despite its low overall DSM risk management ranking, a distinguishing attribute of the Existing Facilities model (as well as the PSE&G Standard Offer model) is the inclusion of energy efficiency service providers as eligible participants. ESCOs, engineering firms and equipment vendors provide turnkey implementation services, and often times capital cost financing for host customers. Service providers bundle incentives into energy services marketed to industrial “host” customers and then enter into contracts with the utility to receive funds for the proposed projects. As the performance incentive survey of industrial firms indicated, the appetite for a similar program attribute in BC may be relatively low, particularly with respect to ESCO (Performance Incentive Web Survey 2012). However, some third party energy efficiency service providers would be better suited to participate than others. Equipment vendors and engineering firms who have regular dealings with industrial firms are likely to have greater penetration in the industrial sector compared to ESCOs who tend to operate almost exclusively in the commercial and institutional sectors (Elliot 2002).

7.5.4 BC Hydro PSP-T Project Incentives

BC Hydro’s PSP-T Project Incentive model ranks in the middle of risk management performance. In view of the financial instability of commodity markets served by the large industrial sector in BC and the attendant capital constraints to investment in EEMs, BC Hydro’s strategy for acquiring reliable energy savings is to provide a comprehensive incentive with minimal cash flow impact to customers (BC Hydro 2009a). At the same time, BC Hydro requires robust M&V and contractual performance guarantees. In this respect, PSP-T Project Incentives represent a hybrid of the Standard Offer and Existing Facilities model. Notably, contractual performance requirements have limited participation for some participants lacking the requisite creditworthiness requirements. Currently only two of nine pulp and paper customers pass BC Hydro’s credit policy to make them eligible for Project Incentives (BC Hydro 2009).

Like the Standard Offer, PSP-T Project Incentives pay an incentive rate that is substantially higher than incremental costs. Comprehensive incentives increase participation rates, attracting both retrofit and replacement EEMs.[68] However, in the case of replacement measures, comprehensive incentives put the program at a higher risk of diluting net energy savings due to partial free riders. In BC Hydro’s case, the risk of free riders is partly mitigated by their requirement that participants sign a declaration stating that they have not already engaged a contractor or purchased equipment related to the

[68] As noted in section 3.4.1, retrofitting often means the customer is forfeiting the remaining present value of the less efficient device or system, so incentive levels can range up to full cost of the new measure and installation in order to effectively move the market (U.S. EPA 2008).

EEM. Unlike the Standard Offer, and similar to Existing Facilities, PSP-T Project Incentive pay a substantial portion of the incentive up front based on engineering analysis, with the balance trued up to M&V results. This latter program design features is seen as a critical attribute to minimize capital constraints in the BC large industrial sector (BC Hydro 2009a).

Like the Standard Offer, BC Hydro requires M&V across most projects. Of 42 current projects, all are currently in continuous post-implementation M&V (BC Hydro, August 3rd 2011). As noted in section 2.5, this is partly attributed to the exclusive focus of PSP-T on large industrial end-uses compared to the relatively high percentage of lighting measures in both PSE&G and NYSERDA (Ibid.). Notably, although PSP-T's Project Incentives employ rigorous M&V, the resource invested are project specific and thus BC Hydro is not able to achieve M&V cost efficiencies as in program such as Track and Tune.

As the base case for this analysis, the PSP-T Project Incentive model represents a reasonable program design to maximize reliable energy savings given BC large industrial sector conditions and the stated BC Hydro objective of direct resource acquisition. However, beyond the individual program models, there is an opportunity to combine performance incentive attributes that scored highest in their respective risk management categories into alternative program designs that may broaden energy savings potential and achieve synergies in energy savings reliability and cost-effectiveness.

7.6 Alternative Performance Incentive Option Identification

Two hybrid performance incentive program options can be identified from the highest scoring performance incentive program attributes: (1) a performance tracking system-based, open end-use standard offer model and (2) a performance tracking system-based, open end-use project incentive model. The first option would pay incentives for ex post energy savings from capital as wells as O&M EEMs. The second option would pay incentives for energy savings from capital and O&M EEMs, except a portion of the total estimated incentive would be paid upfront, followed by a series of progress payments trued up to actual energy savings.

Including energy services providers as eligible participants in both options could address the lack of customer internal resources barrier and offer cost-efficiencies in marketing and cross-sector EEM implementation. As in the Standard Offer and Existing Facilities, energy service providers would bundle the incentive into energy services marketed to the industrial sector and then enter into contracts with BC Hydro to receive funds for the proposed projects.[69]

The potential benefits of both approaches include a combination of addressing industrial firm constraints to EEM investment, cost-efficiencies in high quality M&V and the enabling of energy system performance feedback. As a prelude to future possible policy analysis, what follows is an outline of both program options and discussion of their respective challenges and opportunities in view of BC Hydro and industrial firm conditions and constraints.

[69] While ESCOs potentially have value to add to a performance incentive program in BC in terms of offering turnkey services and performance guarantees, their role would likely have to be required by BC Hydro for industrial firms to utilize their services in a program offering.

7.6.1 Option 1: Performance tracking system, open end-use standard offer

In this option BC Hydro would pay incentives for ex post annual energy savings from capital and O&M EEMs. CUSUM performance data would be assessed annually for energy savings by BC Hydro via the performance tracking system, perhaps in conjunction with the annual Transmission Service Rate customer baseline review to streamline the process. Contract length could range from two to five years or alternatively, an open offer format could be utilized where customers submit annual energy savings from documented EEMs to maximize ease of participation. Incentive level would be set based on a market assessment of what is required to incent participation while remaining cost-effective and without unduly detracting from other program offerings. The incentive could be price differentiated for specific end-uses to promote particular technologies and practices. Customers would not need to meet creditworthiness requirements or otherwise submit letters of credit, as the incentives would only be for measured energy savings. Liquidated damages provisions may be desirable however to ensure that proposed projects are brought online in accordance with planned energy savings. Minimum payback requirements could be applied to capital projects to limit free riders, but may be problematic in an open offer format. The benefits of this approach include linking a standard offer to a performance tracking and feedback mechanism with potential M&V cost-efficiencies, including low-cost O&M EEMs as well as capital EEMs, eliminating creditworthiness requirements and paying only for performance.

The first challenge to the performance tracking – standard offer option is the lack of upfront capital could limit participation for firms experiencing capital constraints. To minimize this barrier, it has been suggested by BC Hydro that customers could use the cash flow guaranteed by a performance incentive contract to obtain project-specific financing from a third party (BC Hydro 2009). This could be advantageous for customers with low credit ratings whose participation in PSP-T Project Incentives is limited by BC Hydro's current credit policy. In practice, however, EEM-specific project financing appears doubtful according to one large financial institutions who serves utilities and the large industrial sector in BC (Bank of Montreal, September 27th 2011). Lenders are unlikely to provide project financing tied exclusively to a project's cash flow, regardless if it is from a guaranteed long-term incentive, unless the cash flow is "substantial" and even then, interest rates will be higher than more conventional forms of lending (Ibid.). For now, approval for EEM financing is based on a firm's overall creditworthiness and terms are no different than other asset-based lending.

Given the response from industrial firm survey participants that lack of access to suitable financing was not a factor limiting investment in energy efficiency, the lack of EEM-specific financing may be less important in the context of a standard offer program (Performance Incentive Web Survey 2012). Future research is required to accurately determine the extent to which limited access to financing for EEMs is a barrier to DSM program participation, and EEM investment in general, across the large industrial sector. Nevertheless, even in the absence of project financing availability for capital projects, industrial customers with capital constraints and low credit ratings could still participate in the program, focusing on low-cost EEMs like O&M improvements that could provide significant cash flow in addition to energy system benefits.

The second challenge is that if the program were to offer up to five-year contracts similar to Track and Tune, funds would need to be committed over multiple utility budgets cycles. Accordingly, there would need to be strong support for this option both within BC Hydro and the provincial government for its long-term success.

7.6.2 Option 2: Performance tracking system, open end-use project incentive

Similar to the current PSP-T Project Incentive design, in this option BC Hydro would pay a portion of the incentive upfront based on engineering estimates of energy savings. The remaining balance would be dispensed in a series of progress payments trued up to CUSUM documented energy savings via the performance tacking system. Contract duration could be two years to keep within budget cycles while ensuring energy savings persistence. Like Option 1, incentive level would be determined based on a market assessment of what is required to incent participation while remaining cost-effective and without unduly detracting from other program offerings. Incentives could be price differentiated for specific end-uses to promote particular technologies and practices and otherwise minimize “cream skimming.” Minimum payback, creditworthiness, security requirement and a liquidated damages provision, as per current Project Incentive rules, would only apply to capital projects. Similar to Option 1, the benefit of this approach is to link project incentives to a performance feedback mechanism with potential M&V cost-efficiencies and enable low-cost participation by including O&M EEMs. While the project incentive model represents a second best performance incentive design for ensuring the acquisition of energy savings compared to the exclusive pay for performance standard offer model, it effectively addresses capital constraints by providing a portion of the incentive up front, maintains a program design that is relatively familiar to both BC

Hydro and industrial customers and is manageable in terms of current utility budget cycles.

The challenge to this approach is primarily in estimating energy savings from O&M measures upon which the initial upfront incentive would be based on. The parameters used in calculations of energy savings estimates for capital project EEMs are narrowly defined compared to O&M improvements which could include multiple behavioural and procedural parameters. O&M energy savings estimates are thus likely to be resource intensive. Option 1 circumvents this challenge by paying exclusively for measured energy savings.

7.6.3 Applying Alternative Performance Incentive Program Models to BC

In view of aggressive provincial DSM mandates, the performance incentive options detailed above offer the potential to maximize planned energy savings reliability by effectively managing DSM risk. Drawing from the highest ranking DSM risk management attributes, the models address BC constraints to energy efficiency investment, manage the risk of stranded utility investment, offer rigorous yet streamlined M&V, and enable energy system performance feedback. Looking at the broader PSP-T industrial DSM portfolio, both options could fill a niche that complements other program offerings. PSP-T Project Incentives could for example be directed towards relatively straightforward retrofit capital EEMs while Options 1 or 2 could be reserved for complex capital EEMs and O&M improvements. Furthermore, by including O&M improvements in a directly measurable framework, both options present an opportunity to diversify the overall source of reliable energy savings in the PSP-T portfolio. While the performance incentive options potentially offer greater certainty of energy savings, they both require a relatively high level of resources upfront and are likely to come at a cost that is at minimum comparable to BC Hydro's PSP-T Project Incentive program. Further research is needed to conduct detailed cost benefit analysis of the performance incentive program options to assess their value as future program offerings.

7.7 Conclusion

Of the programs considered, the DSM risk management criteria analysis indicates the Standard Offer and Track and Tune performance incentive models offer the greatest potential to effectively manage DSM risk in BC and thus result in reliable energy savings. However, this potential comes at a cost in terms of limited energy savings potential in the case of Track and Tune which focuses exclusively on O&M measures and at a cost premium in the case of the Standard Offer. Beyond the individual program models, however, there is an opportunity to combine performance incentive attributes that scored highest in their respective risk management categories into alternative program designs that may broaden energy savings potential and achieve synergies in energy savings reliability and cost-effectiveness. The program model analysis suggests the following attributes have the greatest potential to manage DSM risk in the BC large industrial sector:

- Incentives offered jointly for capital and low-cost O&M measures that are structured to address capital constraints in each subsector (i.e. incentives provided upfront or ex post and covering incremental to comprehensive project costs as needed to move the market).
- Flexible lead times for project development.

- Rigorous M&V methods capable of measuring variable load, process-based energy savings.

- Moderate contract lengths that align more closely with the effective life of the EEM and transfer the risk of project underperformance to the participant.

- Energy management software tools capable of providing energy performance feedback to customers to maximize the persistence of energy savings and streamline M&V.

Accordingly, two alternative performance incentive program models synthesizing the highest-ranking program attributes were identified. The models include: (1) a performance tracking system-based, open end-use standard offer model and (2) a performance tracking system-based, open end-use project incentive model. The first model would pay incentives for measured energy savings from capital and O&M EEMs. The second option would pay incentives for energy savings from capital and O&M EEMs, except a portion of the total incentive would be paid upfront, followed by a series of progress payments trued-up to actual energy savings. Contract lengths in both models would range from two to five years depending on the EEMs.

8 Conclusion

DSM programs provide multiple streams of benefits to society and energy consumers. In minimizing the need for energy supply acquisition, DSM programs reduce the environmental impacts of energy systems, both in terms of carbon emissions and site-level impacts from generation development. At the same time, DSM programs help to reduce operating costs for consumers and thus provide a buffer to rising energy prices. In the industrial sector, DSM helps to enhance competitiveness by minimizing the amount of energy required to produce goods.

For DSM administrators faced with aggressive jurisdictional energy efficiency requirements, performance incentive program models can be an effective means to maximize the reliability of planned energy savings in the large industrial sector. Performance incentive programs balance the objectives of high participation rates with persistent energy savings. They do this by providing financial incentives and resources to address constraints to investment in energy efficiency and requiring that incentive payments be dependent on measured energy savings over time.

As BC Hydro increases its DSM initiatives to meet the *Clean Energy Act* objective to reduce at least 66 per cent of new electricity demand with DSM by 2020, the utility is faced with a higher level of DSM risk. For industrial DSM incentive programs, DSM risk can be broken down into project development and project performance risks. Development risk represents the project ramp-up phase and is the risk that planned energy savings do not materialize due to low customer response to program incentives or that projects are not implemented successfully in customer facilities. Performance risk represents the operational phase and is the risk that planned energy savings do not persist over the effective measure life. DSM project development and performance risks are, in turn, a result of industrial economic, technological and organizational conditions, or DSM risk factors. In the BC large industrial sector, and characteristic of large industrial sectors in general, these DSM risk factors include: (1) commodity market-driven financial instability, (2) capital constraints to investment in energy efficiency, (3) limited internal staffing resources to deploy towards energy efficiency, (4) variable load, process-based energy saving potential, and (5) a lack of organizational awareness of an operation's energy efficiency over time (i.e. energy performance feedback).

This research assessed the capacity of different performance incentive program designs to manage DSM risk in BC. Three performance incentive program models were assessed and compared to BC Hydro's current large industrial DSM incentive program, Power Smart Partners – Transmission Project Incentives, itself a performance incentive-based program. The selected performance incentive models represent a continuum of program design and implementation in terms of the schedule and level of incentives provided, the duration and rigour of M&V, energy efficiency measures targeted and involvement of the private sector.

Of the programs considered, the DSM risk management criteria analysis indicates the Standard Offer and Track and Tune and performance incentive models offer the greatest potential energy savings reliability if they were applied in BC. PSE&G's Standard Offer ranked highest in the capacity to transfer performance risk away from ratepayers on account of paying incentives only for measured energy savings, requiring security be submitted and a liquidated damages fund be established for all projects, and having long-term contracts up to fifteen years in duration. The incentives promote investment in energy efficiency by providing participants with a long-term revenue stream. Energy efficiency service providers offer or arrange for financing to overcome the lack of upfront incentives and provide project implementation services. BPA's Track and Tune ranked highest in addressing resource constraints on account of its emphasis on low-cost O&M improvements that do not require capital or customer creditworthiness. BPA's Track and Tune program ranked highest in the capacity to ensure and support the persistence of energy savings from energy efficiency measures. Track and Tune continuously measures energy use and key energy driving factors over the entire length of the three to five year contract. The performance tracking system implemented in industrial facilities with Track and Tune is designed to measure energy savings from multiple O&M improvements over time and act as an energy management enabler by providing real-time performance feedback.

While the Standard Offer and Track and Tune program models ranked highest in energy savings reliability, their potential comes at a cost. Track and Tune is limited in energy savings potential as it focuses exclusively on O&M measures has no contractual performance requirements. The Standard Offer comes at a cost premium. The PSP-T Project Incentive program strikes a balance, placing highest in total resource cost-effectiveness and ranking in the middle of risk management performance. However, the rigorous contractual performance requirements in the PSP-T Project Incentive program have limited participation for some industrial firms, particularly in the pulp and paper sector (BC Hydro 2009).

Beyond the individual program models, however, there is an opportunity to combine performance incentive attributes that scored highest in their respective risk management categories into alternative program designs that may broaden energy savings potential and achieve synergies in energy savings reliability and cost-effectiveness. The program model analysis indicates that the following key program attributes have the greatest potential to manage DSM risk in BC: (1) incentives offered jointly for capital and low-cost O&M measures that are structured to address capital constraints in each subsector (i.e. incentives provided upfront or ex post and covering incremental to comprehensive project costs as needed to move the market), (2) flexible lead times for project development, (3) rigorous M&V methods capable of measuring variable load, process-based energy savings, (4) moderate contract lengths that align with effective measure life, and (5) energy management software tools capable of providing energy performance feedback to customers to maximize the persistence of energy savings and streamline M&V.

Accordingly, two hybrid performance incentive options were identified: (A) a performance tracking system-based, open end-use standard offer model and (B) a performance tracking system-based, open end-use project incentive model. The first option would pay incentives for ex post energy savings from capital and O&M measures. The second option would pay incentives for energy savings from capital and O&M measures, except a portion of the total incentive would be paid upfront, followed by a series of progress payments trued-up to actual energy savings. The potential benefits of both approaches include a combination of addressing customer constraints to energy efficiency investment, rigorous but streamlined M&V, and the enabling of energy system performance feedback.

Looking at the broader PSP-T industrial DSM portfolio, both options could fill a niche that complements other program offerings. PSP-T Project Incentives be directed towards relatively straightforward retrofit capital EEMs while Options 1 or 2 could be reserved for complex capital EEMs and O&M improvements. By including O&M improvements in a directly measurable framework, both options present an opportunity to diversify the overall source of reliable energy savings in the PSP-T portfolio.

As the performance tracking system is the foundation for both of the alternative performance incentive models, future research is needed to assess how DSM administrators can address organizational and technological barriers to its broad adoption in the industrial sector in BC. To begin with, future research could focus on how and why industrial firms participating in BPA's Track and Tune program found performance tracking systems to be a beneficial attribute. Also, research could be conducted on the persistence of O&M savings over time. Evaluations of the program expected in F2013 should shed some light on the latter question, as well as provide detail on the program's multi-year impact. Finally, as the performance tracking system is an enabler of energy management practices (e.g. it allow firms to benchmark energy performance, set performance targets, identify energy efficiency opportunities), it forms a new link between resource acquisition incentive programs and energy management system standards such as ISO 50001. The linkage holds potential for DSM administrators to increase the persistence of EEMs and transform the market for energy management practices, thus diversifying from a pure resource acquisition focus. Future research is needed to develop best practices on how DSM administrators can use the tracking system to integrate resource acquisition programs and energy management initiatives.

The implications of this study's finding for DSM in large, energy-intensive industrial sectors beyond BC are largely similar to those for BC. As in BC, performance incentive program models can offer an effective means of managing both project development and performance risk in the industrial sector. The selection of program attributes will depend in part on industrial sector conditions in each jurisdiction. For development risk management strategies, market conditions (i.e. demand for product) and input costs (i.e. energy, labour and efficiency of operations), and resulting capital constraints will be factors to consider in each subsector. The percentage of total incentives paid upfront and project costs covered by the incentive, flexible project implementation timeframes, as well as eligibility for capital and low-cost O&M measures are key program design levers to maximize program participation. M&V-based performance risk management options are likely to be similar across all jurisdictions given the universality of variable load, process-based energy saving potential in large industrial operations. In other words, the reliability of energy savings in the large industrial sector is at risk without rigorous M&V. For DSM program administrators who opt for rigorous M&V, the performance tracking system offers a streamlined and auditable platform that enables persistent savings from both capital and O&M DSM. Moderate contract terms (i.e. two to five years) will be more effective at ensuring the persistence of energy savings from industrial DSM projects as they are more aligned with measure life than short-term contracts.

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Appendix A: Survey of Opportunities for BC Hydro Industrial Energy Efficiency Programs

Welcome You are invited to participate in a study entitled "Effective Design for Minimizing Energy Savings Deliverability Risk in BC Hydro Industrial Energy Efficiency Programs" that is being conducted by Nathaniel Gosman. The BC Ministry of Energy and Mines, BC Hydro and Willis Energy Services are advisors for this study. You are being asked to participate in this study because you represent a BC Hydro Industrial customer. Nathaniel Gosman is a Master of Arts candidate with the Institute for Integrated Energy Systems in the Department of Environmental Studies at the University of Victoria, British Columbia. You may contact Nathaniel by email at ngosman@uvic.ca or by phone at 250-886-1755. The results of this research will be used for a report Nathaniel Gosman is preparing for Willis Energy Services to be presented to BC Hydro, and used in his graduate thesis. This research is being funded by Willis Energy Services in partnership with MITACS-Accelerate. Willis Energy Services provides consulting and third-party services for BC Hydro. The results of this study will be anonymous: the name of your company will be not disclosed at any time, only your Industrial subsector will be referenced.

Purpose, Objectives and Importance of Research

As BC Hydro increases its reliance on demand-side management (DSM) to bridge the electricity supply gap, it is exposed to an increasing level of risk in being able to "deliver" expected energy savings, or deliverability risk. Deliverability risk encompasses the possibility that customers with cost-effective energy savings potential will not respond to incentives for DSM measures due to market "barriers" (e.g. capital constraints or lack of internal resources). Deliverability risk also comprises the possibility that the persistence of DSM measures is less than expected due to deficiencies or limitations in technology, installation, management, or measurement and verification (M&V). An analysis of DSM program risk management strategies used by other jurisdictions may create opportunities for BC Hydro and Industrial customers to pursue greater energy savings

This research examines project development, management and performance in four DSM program models for the non-residential sector and assesses their applicability to the BC Industrial sector. Each selected program addresses deliverability risk from a different angle, focusing for example on addressing specific customer barriers to DSM program participation such as access to capital, including private sector energy efficiency service providers as eligible participants or developing innovative M&V methods that allow utilities to accurately track and incent O&M measures, difficult to isolate process measures and measures implemented in variable production conditions. Instructions

This survey is broken into four sections: (1) Market Conditions (2) BC Hydro Power Smart Participation (3) Program Descriptions and Questions (4) Wrap-up. The third section, which comprises the body of the survey, provides brief adaptations of utility program descriptions along with a summary of program details. Please read through the brief descriptions and answer the following questions which seek to better understand the relevance of these program designs for BC Hydro large industrial customers. The survey should take between 30 minutes and an hour to complete. Please note, I have purposely omitted reference to actual incentive rates in each program description as they vary widely in relation to jurisdictional factors which are out of the scope of this survey. I also wish to focus attention on non-incentive rate program design components and related issues for Industrial customers.

Terms of Consent

Inconvenience
Participation in this study may inconvenience you in the requirement of up to 1 hour to fill out the survey.

Risks
There are no known or anticipated risks to you by participating in this research.

Benefits
From a participant and societal perspective, the study will result in knowledge that may have the economic benefit of reducing electricity supply expenses and creating valuable investment opportunities, as well as the environmental benefit of reducing environmental impacts associated with procuring new energy supply (e.g. siting, GHG emissions, etc.).

Compensation
There will not be any financial compensation for your participation in this study. Voluntary Participation Your participation in this research is voluntary. You have an absolute right to: (1) withdraw at any time for any reason; (2) not to provide a reason or rationale for withdrawing; (3) skip any questions that you do not wish to answer in the survey. Anonymity Neither the name of your company nor your job title will be disclosed at any time, only your Industrial subsector will be referenced in the results.

Confidentiality
The confidentiality of your data will be protected. Surveys will not identify you or your company, and electronic copies will be stored on a password-protected project laptop while data is being collected. The laptop will be kept as secure as possible throughout the research. When the research is complete, the surveys will be transferred to flash rom and stored in a locked filing cabinet in Nathaniel Gosman's office at the University of Victoria. The surveys will then be removed from the project laptop.

Dissemination of Results
It is anticipated that the results of this study will be shared with others in the following ways: report prepared for BC Hydro, thesis, published articles, as well as possible presentations at scholarly and/or Industry meetings and conferences. Commercial Use of Results This research may be used to inform the design of a BC Hydro Power Smart Partners – Transmission demand-side management program.

Disposal of Data

Data from this study may be stored until August 2021 in its original form. After this date, data will be disposed of by deleting all electronic files.

Contacts

If you have any questions regarding this study, please contact Nathaniel Gosman by email at ngosman@uvic.ca or by phone at 250-886-1755. Nathaniel's supervisor, Dr. Karena Shaw, can be contacted at shawk@uvic.ca or by phone at 250-721-7353. In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca).

Free and Informed Consent

By clicking next, you indicate your free and informed consent and that you understand and agree to the above conditions of participation in this study.

Please print a copy of this letter for your reference.

Market Conditions

Particpant Information

These fields are required for internal purposes only. Neither the name of your company nor your job title will be disclosed at any time, only your Industrial subsector will be referenced in the results.

Company [ ]

Job Title [ ]

Key business priority for your company currently

○ Increased production

○ Cost savings

○ Both

○ Other ____________________

How would you characterize electricity usage trends for your company in the next 3-5 years and what are the primary drivers impacting these trends?

[ ]

BC Hydro Power Smart Participation

Is your company currently participating in BC Hydro Power Smart programs? If so, what programs?

[ ]

Rate the following barriers to greater Industrial customer participation in BC Hydro's Power Smart Project Incentive Program

	Low	Moderate	High
Capital availability	○	○	○
Upfront cost requirements	○	○	○
Credit requirements	○	○	○
Reluctance to have customer baseline (CBL) adjusted	○	○	○
High internal rate of return requirements for energy efficiency investment	○	○	○
Low electricity rates	○	○	○
Lack of information regarding Power Smart offers and/or available energy efficiency products and services	○	○	○
Transaction costs	○	○	○
Letter of credit requirments and liquated damages exposure	○	○	○
Limited internal resources to design and execute projects	○	○	○
Concerns about the risk of project performance	○	○	○
Lack of strategic importance of energy efficiency to your company currently	○	○	○
Internal debt capacity	○	○	○
The degree and complexity of measurment and verfication (M&V) required	○	○	○

What benefits, if any, do you believe BC Hydro measurement and verification (M&V) requirements for energy efficiency projects installed with Power Smart Project Incentives offer?

Program Descriptions and Questions

(1) Track and Tune - Bonneville Power Administration (BPA), Pacific Northwest

Track and Tune is designed to financially and technically help Industrial customers "do the little things well" while installing a tracking system that allows utility staff and end users the ability to track energy performance and savings over multiple years. Track and Tune centers on operations and maintenance (O&M) savings, instead of large capital projects. To achieve solid savings on industrial projects, Track and Tune assists in the implementation of a Monitoring Tracking and Reporting (MT&R) system that continuously tracks the performance of the area of focus (e.g., whole facility, system, or process). The MT&R system is based on an energy performance model that relates energy consumption to key production variables. The performance model can be integrated with a new or existing energy management information system, plant control system, or turn-key online energy tracking tool. The MT&R system establishes a dynamic baseline based on variation of the key production variables, against which the performance of O&M measures can be tracked over time. This methodology transforms industrial O&M improvements into a reliable, long-term source of savings and provides end-users with a powerful energy management tool that promotes continuous improvement. Track and Tune provides incentives to (1) scope O&M measures, (2) implement an MT&R system, (3) perform an initial O&M "Tune-up" and implement an O&M "Action List", followed by (5) an annual incentive for persistent energy savings for up to 5 years.

Program Details

Eligible applicants: Large Industrial customers

Eligible measures: Operations and Maintenance

Project implementation participants:

- Scoping and initial O&M Tune-up: qualified consultant or customer
- MT&R system implementation: BPA MT&R team
- O&M Action List implementation and Sustained Savings: customer

Incentives:

- Scoping and O&M Tune-up funded up to 100%
- Action List O&M item implementation funded up to 70%
- $10,000-50,000 for MT&R system set up and monitoring
- An annual $/kWh incentive is paid retroactively at the end of each year for persistent energy savings for up to 5 years

M&V: Tracking data from MT&R system is assessed by BPA for energy savings annually

Perceived level of effort to participate in a Track and Tune-like program relative to perceived benefit

Effort
○ Low
○ Moderate
○ High

Benefit
○ Low
○ Moderate
○ High

Please elaborate on your selection of perceived benefit level

Would requiring your company to implement an MT&R system as a prerequisite to participating in a Track and Tune-like program be a possible barrier to participation?

○ Yes

○ No

If yes, if the cost of implementing a MT&R System were fully funded by the utility, would the requirement still be a barrier for participation? Please elaborate.

In addition to the ability to track O&M savings, an MT&R system has the capacity to track saving from capital energy efficiency projects, including difficult to isolate process measures and measures implemented in variable production conditions. Rate your company's potential interest in a Track and Tune-like program that offers incentives for capital projects - where an annual $/kWh incentive is rebated retroactively for energy savings documented with an MT&R system:

○ Low

○ Moderate

○ High

(2) Standard Offer Program – New Jersey Public Service Electric and Gas (PSE&G)

The Standard Offer is a performance-based program that pays for measured energy savings over a 5, 10, or 15 year contractual term. Customers and providers of energy-related services that participate in the Standard Offer program are paid for measured savings through the installation of energy-savings equipment or materials. Participants must guarantee to save a specific amount of energy over the contract term.

Program Details

Eligible applicants: Commercial and Industrial customers and energy efficiency service providers (energy service companies, vendors, energy management firms)

Eligible measures: Any piece or system of equipment or material which improves the energy efficiency of a new or existing, ongoing end-use such as lighting, drive-power, cooling, and heating and provides savings that can be measured and verified

Project implementation participants: Commercial and Industrial customers; energy efficiency service providers

Contract length: 5, 10 or 15 years

Incentive: A time differentiated $/kWh incentive (based on time of day and season) is paid monthly for the full term of the contract based on M&V results; two incentive options:

- *Unlevelized:* incentive rate varies for each year of the contract term in relation to each year's projected value of the energy savings to PSE&G (based on the avoided cost of new supply). Payments escalate over the term of the contract
- *Levelized:* incentive rate is the same amount for each year of the contract term based on an applicable discount rate

M&V:

- Pre-implementation, implementation and annual post-implementation audits
- Continuous long-term metering at every site
- If savings fall below contract specified levels, PSE&G reduces payments to the seller

Perceived level of effort to participate in a Standard Offer-like program relative to perceived benefit

Effort
- ○ Low
- ○ Moderate
- ○ High

Benefit
- ○ Low
- ○ Moderate
- ○ High

Please elaborate on your selection of perceived benefit level

[ ]

Rate the compatibility with your company's business operations of entering into a long-term, Standard Offer-like contract with BC Hydro to deliver energy savings:

- ○ Low
- ○ Moderate
- ○ High

Please elaborate

[ ]

While the Standard Offer did not offer an upfront capital incentive, it was designed to encourage project sponsors such as energy service companies to provide or arrange for project financing for customers. Accordingly, in a Standard Offer-like program, rate your company's potential interest in offers to finance energy efficiency measures from a third party where project capital requirements would be provided upfront and the debt would be paid off in annuities from long-term energy savings incentives?

- ○ Low

- ○ Moderate
- ○ High

Given the requirement for continuous long-term M&V in a Standard Offer-like program, if your company was to participate, would you prefer the current BC Hydro approach to M&V or M&V via an MT&R system as described in the previous section?

- ○ M&V via the current BC Hydro approach
- ○ M&V via a Monitoring, Tracking and Reporting System

Please explain your preference

Which procurement format would your company prefer if participating in a Standard Offer-like program offering long-term contracts for delivered energy savings?

- ○ Standard Offer
- ○ Call for Bids
- ○ Request for Proposals

Please explain your preference

(3) Enhanced Commercial & Industrial Performance Program – New York State Energy Research and Development Authority (NYSERDA)

The Enhanced Commercial/Industrial Performance Program promotes energy-efficiency and demand reduction through capital improvements. The program supports the development and expansion of the energy service industry by offering performance-based incentives for energy projects delivering verifiable annual electric energy savings to energy service providers. The incentives are provided through a Standard Performance Contract between NYSERDA and the contractor. The contract between the customer and the contractor can be an energy performance contract or a fee-for-service contract. The amount of the incentive passed through to the customer is negotiable between the contractor and the customer.

Program Details

Eligible Applicants: Energy efficiency service providers (energy service companies, vendors, energy management firms) implementing energy efficiency measures for Commercial and Industrial customers

Eligible measures: Lighting, motors, variable speed drives, energy management systems, HVAC, and custom measures

Project implementation: Energy efficiency service providers

Incentives:

- For measures not requiring extended M&V, 100% of a $/kWh incentive is paid after post-installation inspection
- For measures requiring extended M&V, 60% of a $/kWh incentive is paid upon installation and the balance after NYSERDA receives and approves the final M&V report

M&V:

- Pre and post-installation inspection
- 2 years extended M&V for measures where the reliability and persistence of savings are not certain
- Final incentive levels are adjusted based on the M&V results

Perceived level of effort to participate in an Enhanced Commercial & Industrial Performance-like program relative to perceived benefit

Effort
- ○ Low
- ○ Moderate
- ○ High

Benefit
- ○ Low
- ○ Moderate
- ○ High

Please elaborate on your selection of perceived benefit level

[ ]

Rate your company's potential interest in working with energy efficiency service providers who receive Power Smart Project Incentives directly to identify, arrange financing if necessary and implement energy efficiency measures at customer sites (similar to the Enhanced Commercial & Industrial Performance Program):

- ○ Low
- ○ Moderate
- ○ High

Has your company outsourced any energy services?

- ○ Yes
- ○ No

If yes, what services and how would you rate your company's experience? Under what conditions would your company outsource energy services again?

[ ]

Rate the compatibility with your company's business operations of entering into an energy performance contract - where an energy service company, equipment vendor, or energy management firm provides a turnkey energy efficiency improvement accompanied with a contractual guarantee that the savings produced by the project will be sufficient to finance the full cost of the project:

○ Low

○ Moderate

○ High

Please explain

[ ]

Wrap Up

Please rate your company's prospective interest in the program models described in this survey

	Low	Moderate	High
Track and Tune	○	○	○
Standard Offer	○	○	○
Enhanced Commercial & Industrial Performance Program	○	○	○

If you indicated a high potential interest in one of the described program models, please comment on the added value or benefit this program type might contribute to the current BC Hydro Power Smart offerings for the Industrial sector

Program [ ]

Comment [ ]

Additional comments or feedback?

[ ]

Thank you for your time

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