Session 4
Understanding the EE Project Lifecycle

Energy Efficiency Training Seminar

Central and West Asia Region

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Agenda

- Framework for EE project lifecycle
- Case studies
  - Commercial project
  - Residential project
- Developing vs. developed country
  - Implementation and adoption

Agenda

- **Framework for EE project lifecycle**

- Case studies
  - Commercial project
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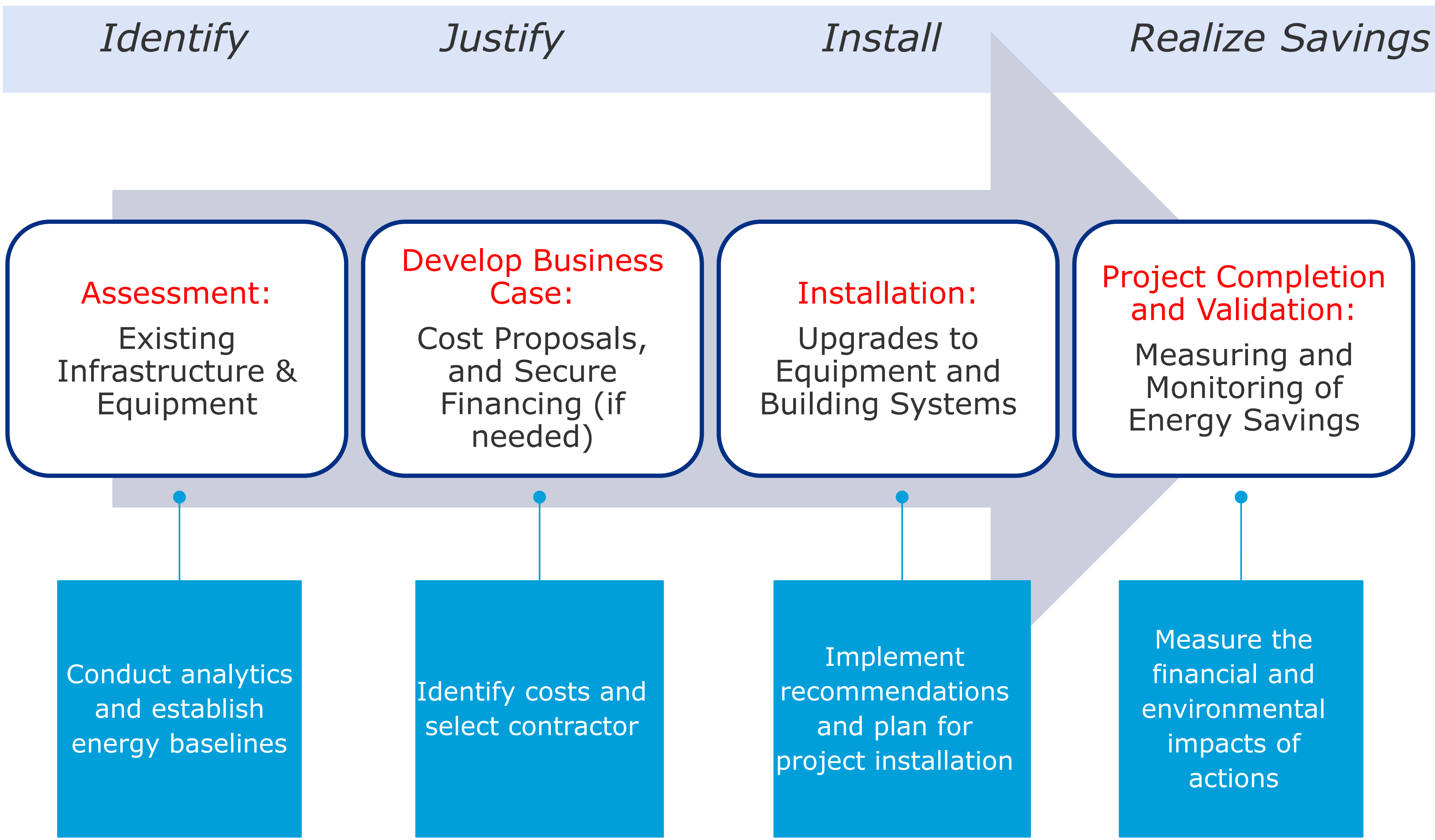
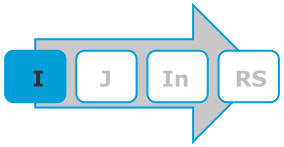
Framework for Energy Efficiency Project Lifecycle



Identify potential sustainability and energy efficiency measures



Typical key activities

- Energy audits
- Assess operational and maintenance issues
- High level portfolio assessment
- Retro-commissioning studies
- Benchmarking / facility stock ranking
- Develop on-going energy performance monitoring/reporting framework
- Develop performance indicators for sustainability measures
- Review planned capital expenditures

There a number of key areas for potential savings to target

Customer segment	Key areas for savings opportunity
1. Commercial and institutional building owners and tenants	• Lighting • HVAC • Building automation
2. Residential	• Appliances • Lighting • HVAC
3. Industrial customer	• Process heating and cooling • Pumping • Compression • Motors • Process controls

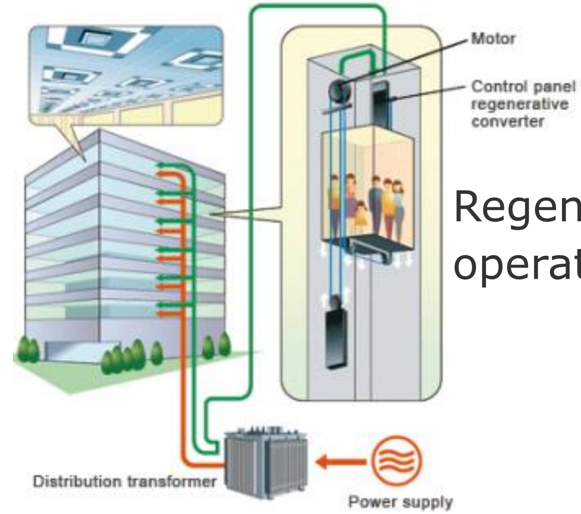
Opportunity identification must include a three step strategy

1. **Minimize load**

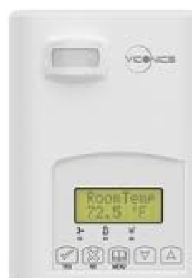
2. **Optimize use**

3. **Energize solutions**

Demand Control Ventilation



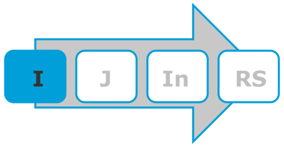
Regenerative operation



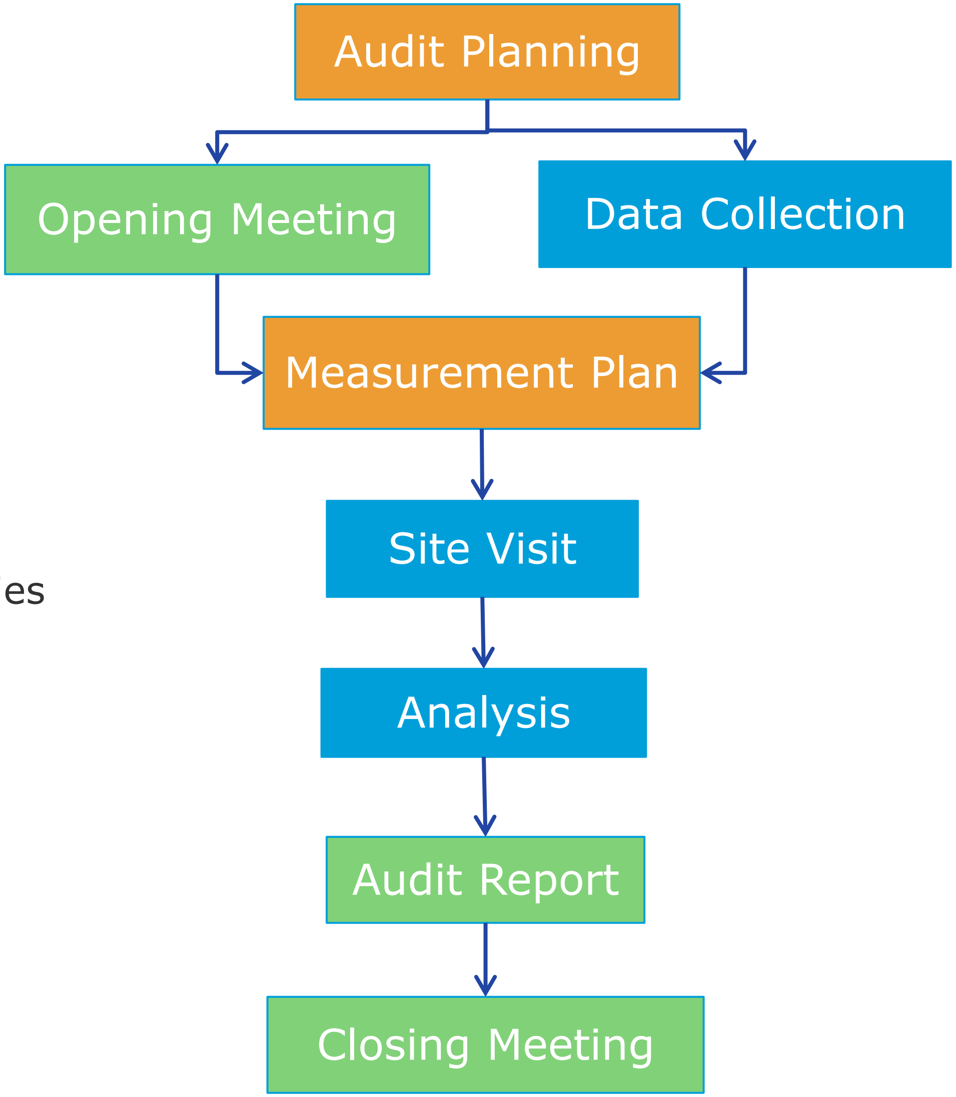
Setpoints & Schedules

Lighting Controls

The audit process is a key first step in identifying opportunities



1. Energy audit planning
2. Opening meeting
3. Data collection
4. Measurement plan
5. Conducting the site visit
6. Analysis
   – Analysis of current energy performance
   – Identification of improvement opportunities
   – Evaluation of improvement opportunities
7. Energy audit reporting
8. Closing meeting



There are three types of audits

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- **Level 1** is suitable for high level overview
  - Lowest cost audit type
  - Suitable for majority of small sites
  - Can be used at larger sites to prioritize areas for investigation
  - Also referred to as screening audit, walkthrough audit, checklist audit
- **Level 2** is suitable where more technical details and a greater confidence in prediction are required or desired
  - Cost varies depending on level of detail required
  - Suitable for any size site or targeted system
  - Can involve metering and monitoring of devices and systems
- **Level 3** is for opportunities with high capital cost and risk
  - Highest cost audit type
  - Also referred to as investment grade audits
  - Involves extensive metering and monitoring of all devices and systems

There are a number of audit protocols already in place to adopt

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- IPMVP is the International Performance Measurement and Verification Protocol
  - Used world wide as the basis for analysis of energy efficiency measures
  - Identifies 4 basic analysis options
    - Option A: Retrofit isolation: Key parameter measurement
    - Option B: Retrofit isolation: All parameter measurement
    - Option C: Energy data issues
    - Option D: Calibrated simulation
- EN 16247-1 is the European Standard for Energy Audits
- ISO 50002 is a new international standard for Energy Audits
  - Draft standard has been issued and is currently being balloted for approval
  - Expected publication in 3rd quarter of 2014
- FEMP Guidelines are used for audits under the Federal Energy Management Program in the US
- NEMVP Guidelines are used for North American (US and Canada) audits

A successful audit depends on the quality of the auditing professionals

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- **Level 1 Auditors**
  - Knowledge of building equipment, systems and controls
  - Knowledge of industrial equipment, systems and controls
  - High school diploma
- **Level 2 Auditors**, in addition to Level 1 requirements
  - College degree in engineering or related science
  - Proficient in mathematical analysis and computer simulation
  - Knowledgeable in the use and application of statistical methods
  - 5 years experience operating, maintaining, designing, or constructing buildings or industrial facilities
- **Level 3 auditors**, in addition to Level 1 requirements
  - Advanced college engineering degree or PE
  - Proficient in the use and application of statistical methods
  - Proficient in economic analysis

We must build the business case for making the energy efficiency investment

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- Assess potential benefits and possible risks of proposed projects, improvements, certifications (risk management)

- Collect cost proposals from contractors
  - Energy modelling
  - Technology assessment
  - Economic assessment (asset optimization)

- Identify funding sources (utility and government rebates, tax incentives, and performance contract financing)

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Targeted supportive legal frameworks to help justify reduction efforts

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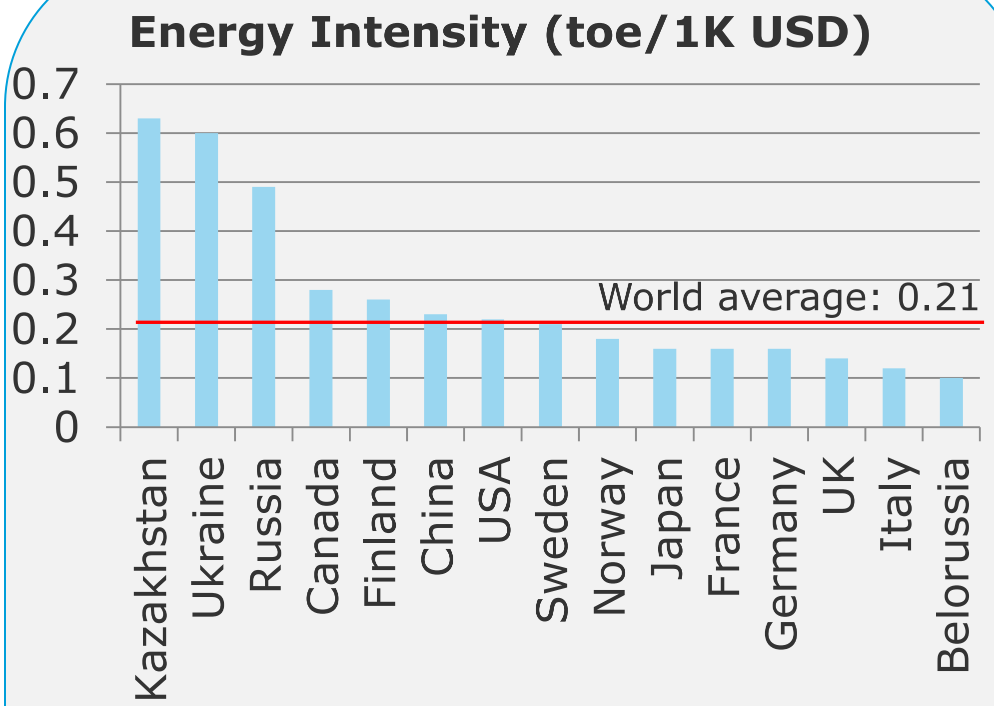

Source: Alexander Gusev, German Institute for International and Security Affairs (SWP), 2013

There are many areas that could contribute to high energy intensity and legal and policy frameworks need to be targeted

1. Severe climate conditions or variance
2. Demands on transportation due population distribution vis-à-vis economic activity centres
3. Prevalence of high energy intensity industries as part of national economy
4. Technological backwardness
5. Low energy price due to market structure
6. Lack of building energy standards

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To achieve impact a holistic approach in developing legal frameworks is required

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The need for compliance to different legal and policy frameworks is key to developing the proper justification for energy efficiency projects. These frameworks could include the following by establishing:

1. Design (new and retrofit) and construction standards for buildings e.g., Leads certification, green mark certification,
2. Modal shift policies from private to public transportation that are supported by effective public transport infrastructure development
3. Minimum energy performance standards for domestic appliances e.g., lighting, refrigeration, washing machines, dryers, and heaters
4. Minimum energy performance standards for industrial equipment e.g., electric motors, heat exchangers, compressors, HVACs, pumps,
5. Policies that encourage replacement or retrofitting of under performing /old assets
6. Capability building for programs
7. An electricity market structure and/or energy pricing policies that incentivises energy saving
8. Education and green consumer awareness program to reduce energy wastage
9. Energy Conservation Acts that require the use of energy management protocols, instrumentation standards and obligatory demonstration energy intensity improvements

Financing incentivises stakeholders and balances implementation risk vs returns

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Financing Issues

1 First cost hurdle

- How to finance the initial capital investment in energy efficiency measures at little or no up-front cost to the end-user
- How to enable and incentivize the use of more efficient but potentially more expensive upgrades rather than lower cost, lower efficiency upgrades

2 Timing mismatch

- How to overcome the mismatch between the longer useful lives and varying payback periods of some energy efficiency improvements (such as HVAC equipment) and the sometimes shorter expected occupancy of the property (whether by a property owner or a tenant)

3 Split incentives

- Particularly prevalent in the commercial real estate sector, how to balance the different time horizons and incentives of a tenant versus a property owner

Financing incentivises stakeholders and balances implementation risk vs returns

Financing Issues

4 **Scalability**

- How to achieve scale by aggregation despite the often fragmented and disparate nature of the targeted market and facilities

5 **Existing property or financing restrictions**

- Restrictions under existing mortgages on mortgaged property or under existing debt financing to property owners

6 **Energy baseline measurements**

- Where payments to service providers and sponsors are based on performance, how to establish baseline energy usage and normalize for changes in energy consumption that are not related to the energy efficiency project

A well planned implementation process is key to capture the investment returns

- **Procurement plan**
  - Ensure supply of equipment, critical spares, critical services and manpower well coordinated

- **Manpower plan**
  - ensure appropriate people available to access necessary locations

- **Measurement and verification plan**
  - Collect necessary data of existing equipment prior to replacement
  - Developing a base line prior to upgrade

Savings cannot be measured, it can only be calculated

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- **Annual Energy Savings = (Annual Energy Use Before) – (Annual Energy Use After)**

- **Annual energy used before** the retrofit is called the baseline energy use
  - Determined through measurement and/or calculation extrapolated to one year based on a standard set of conditions of throughput, quality, and demand

- **Energy use after** the retrofit is called the post case energy use
  - Determined through measurement and/or calculation extrapolated to one year based on the same standard set of conditions of throughput, quality, and demand used for the annual baseline energy use extrapolation

- When multiple changes are made to a system or site, some measures can affect the energy use of other measures. This is called **interactivity** and it **must be accounted for** to determine the cumulative savings of all measures.

A robust M&V plan is important to accurately ascertain realised savings

M&V Plan – There are 7 key steps

1. Develop Site Specific M&V Plan
2. Instrumentation Requirements & Calibration
3. Trend/Collect Baseline Operational Data
4. Energy Consumption Procedure after PLC installation
5. Trend/Collect New Operational Data
6. Analysis of Energy Savings
7. Report

M&V Purpose

- Verify that measures were installed (as intended) and are operating as designed
- Measure gross savings of Energy Efficiency measure installation relative to appropriate baseline usage

M&V Protocols

- **PURPOSE**: To guide the collection of empirical data from field installations of energy efficiency technologies

- **CONTEXT:** The increased rigor of M&V helps to reduce evaluation uncertainty
  - Define EE measure baselines
  - Employ ‘standard’ engineering methods
  - Measure equipment performance
  - Capture operational parameters

International Performance Measurement & Verification Protocol

- It was developed to serve the ESCo market, i.e. performance contracts
- It is not an impact evaluation protocol, yet widely adopted or referenced in M&V projects outside performance contracting
- It is a framework of definitions and methods for assessing energy savings
- It is designed to allow users to develop an M&V plan for a specific project using a structured framework
- It was written to allow for flexible, custom M&V plans while adhering to principles of accuracy, transparency and repeatability

IPM&V Protocol have some key M&V plan requirements

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1. Specify the data to be collected pre and post retrofit (i.e. temperature, pressure, kW, etc).

2. Set minimum accuracy guidelines for meters and sensors. This is essential ad the

3. Controller will receive information from these instruments to maintain building comfort as well as optimize energy usage.

4. Describe the methodology that will be used to develop the energy baseline.

5. Describe the methodology that will be used to calculate post-retrofit energy consumption.

6. Establish criteria for normalization of the pre and post energy consumption

Holistic data acquisition is important

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- In-field (on-site) collection of installation and performance data including:
  - Equipment counts/inventory,
  - Observations of operating conditions,
  - Building occupant and operator interviews,
  - Spot measurements at key points
  - Short-term monitoring data
  - Maintenance logs on key related equipment and instrumentation

M&V Publications

- IPMVP, Volume I (2007)
  - Performance Contracts
- California Evaluation Framework, Chapter 7 (2006)
  - Impact Evaluation of Energy Efficiency Programs
- ASHRAE Guideline 14 (2002)
  - ESCO ↔ Customer and ESCO ↔ Utility Transactions/Credits
- FEMP M&V Guidelines (2000)
  - Federal Agency Performance Contracts

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Commercial Buildings Energy Efficiency
Case Study: Energy Management Ford Motor Company

Background:

Brand value to demonstrating energy efficient practices.

Project Description:

- On-site energy audits of 144 Ford dealerships
- Collected data on energy use of lighting, HVAC, refrigeration, controls, and process loads.
- Provided detail site remediation recommendations.
- Analyzed renewable generation opportunities for solar photovoltaic and wind at each site.

Commercial Buildings Energy Efficiency

Case Study: Integrated Energy Audits for High Tech Company

Background:

- Desire to reduce costs associated with energy and water usage.

Project Description:

- Provided integrated energy conservation and demand response.
- Annual savings identified included 6,796,253 kWh per year of electrical and 235,262 therms per year of natural gas.
- These savings would lower the clients greenhouse gas emissions by 4,367,827 tons per year.
- Water savings identified 27,487,446 gallons per year.

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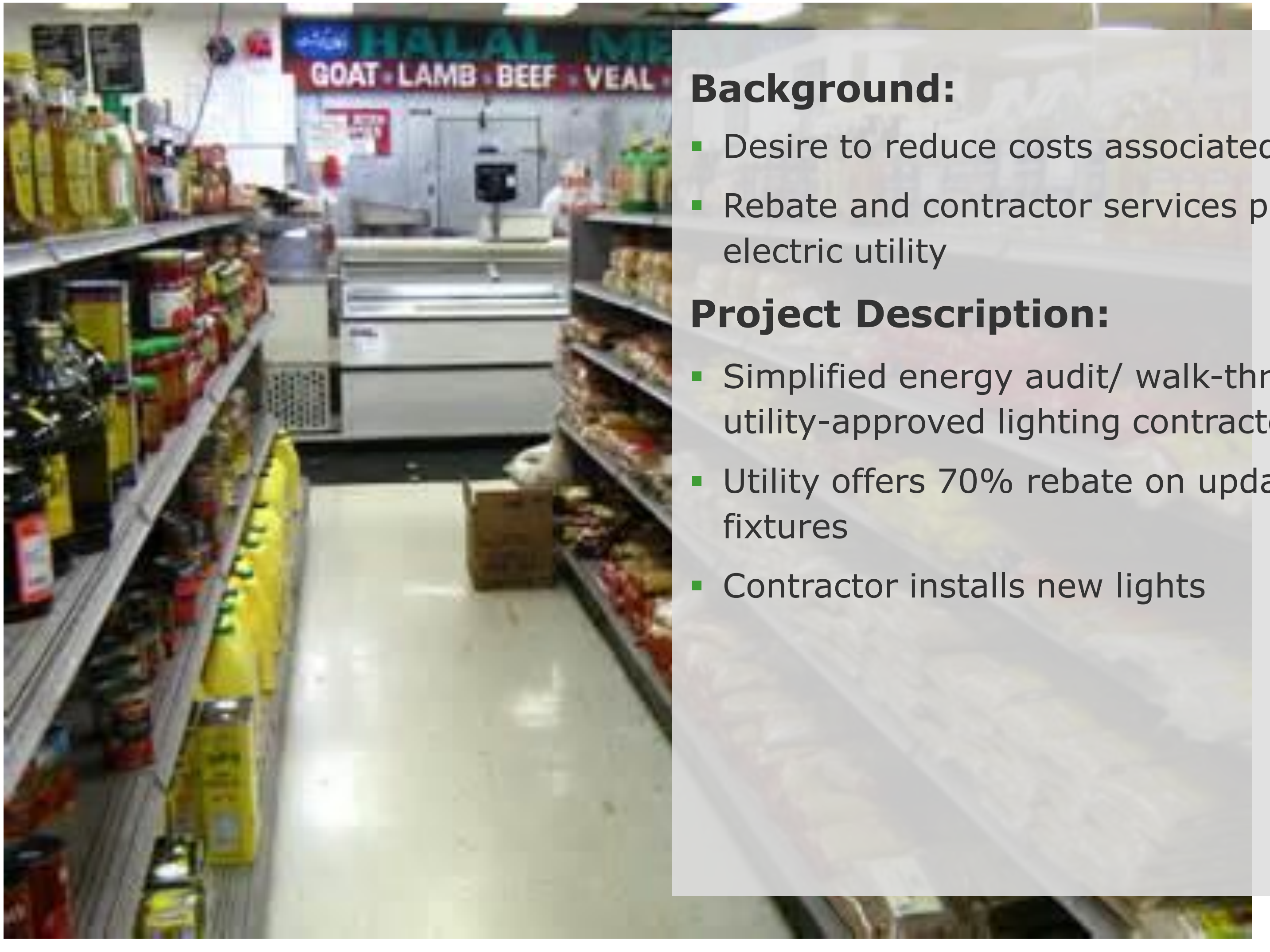
Commercial Buildings Energy Efficiency
Case Study: Grocery Store



Background:

- Desire to reduce costs associated with energy
- Rebate and contractor services provided by local electric utility

Project Description:

- Simplified energy audit/ walk-through provided by utility-approved lighting contractor
- Utility offers 70% rebate on updated lighting fixtures
- Contractor installs new lights

Commercial Buildings Energy Efficiency
Case Study: Grocery Store

- Identify:
    - Contractor uses proprietary tool for assessing opportunities related to lighting and heating, ventilation and cooling
    - Spreadsheet collects information about existing light fixtures
        - Type of light fixture (e.g., T-12, halogen) and wattage
        - Hours of operation
- Justify
    - Contractor uses proprietary tool to calculate estimated energy savings (e.g., replacing lights with T-8 fixtures)
    - Provides cost estimate to grocery store owner
        - Cost of new light fixtures
        - Amount of rebate provided by utility
        - Out-of-pocket costs
        - Estimated annual energy and cost savings
    - Motivation: better light quality and ambience

Commercial Buildings Energy Efficiency
Case Study: Grocery Store

- Install:
  - Lighting project will take one day to finish installation
  - Identify ways to minimize impact on store operations
    - Find a time of day or week that store is normally closed
  - Ensure that contractor keeps work site clean and tidy

- Realize Savings
  - Use utility bills to check change in energy use
  - Challenges include:
    - Weather impacts on energy usage
    - Occupancy changes
    - Changes in store hours
  - Policy perspective: ensure fixtures installed

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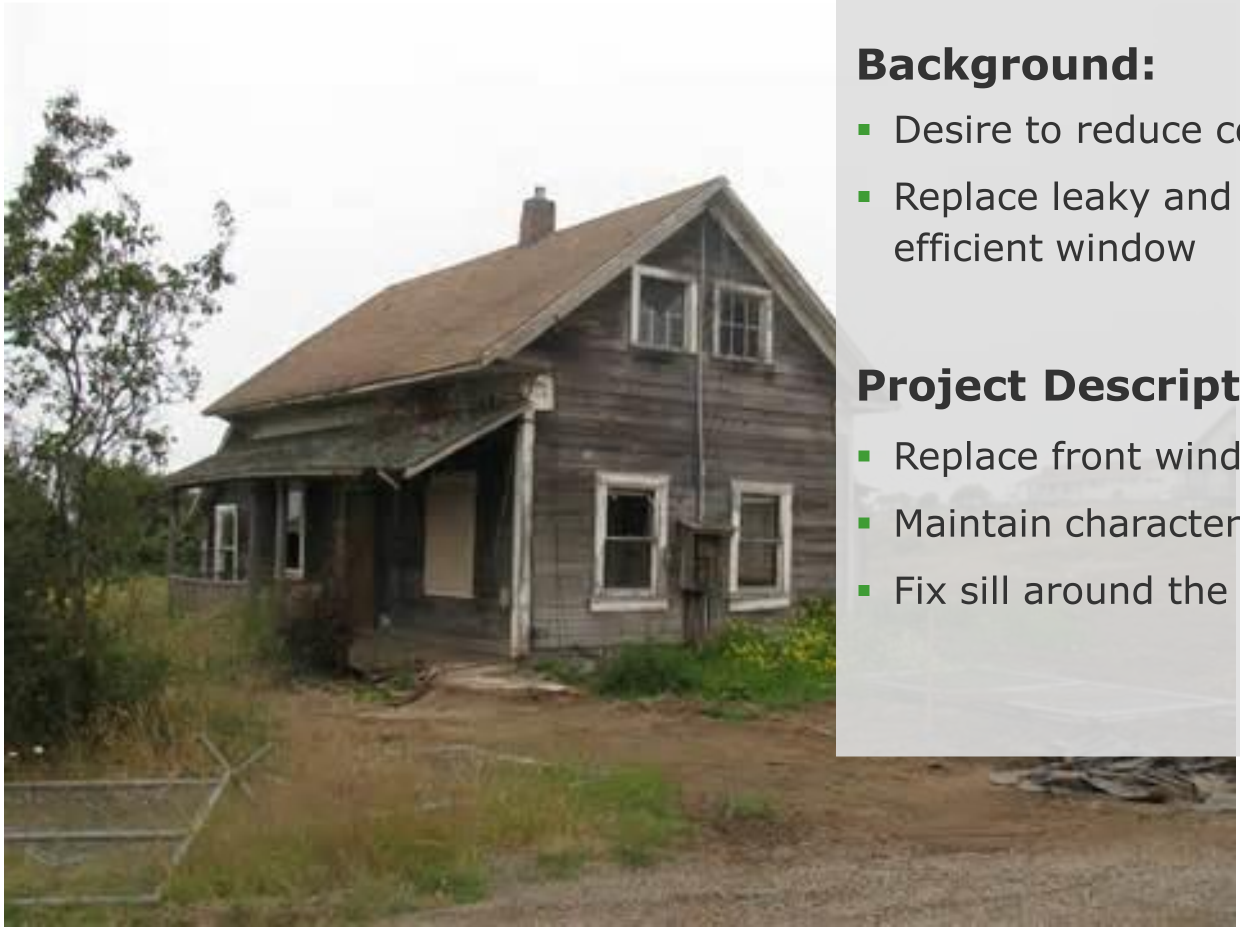
Residential Buildings Energy Efficiency

Case Study: Window replacement



Background:

- Desire to reduce costs associated with energy
- Replace leaky and rotting windows with more efficient window

Project Description:

- Replace front windows
- Maintain character of original windows
- Fix sill around the original windows

Residential Buildings Energy Efficiency
Case Study: Window replacement

- Identify
  - Obtained cost estimates from different window contractors
  - Understand different window technologies and characteristics:
    - Material: Vinyl versus wood
    - Low emissivity
    - Double-paned
  - Cost trade-off between different materials and window products
- Justify
  - Cost estimates to include installation, materials costs, warranties
  - Energy savings estimated based on industry assumptions
    - Climate, electricity and natural gas costs
    - Watch out for contractors who don't have rigorous methods for calculating energy savings (e.g., use oil estimates, when home uses natural gas)
  - Ultimately, non-energy benefits may be main driver for project

Residential Buildings Energy Efficiency
Case Study: Window replacement

- Install
  - New windows replaced in one day
  - Children needed to be away from work site
  - Adequate access to exterior façade of home
  - Schedule around family activities (e.g., weddings, guests, etc)
- Realize savings
  - Since non-energy benefits are primary driver
  - Focus on satisfaction and comfort
    - New windows make house much less hot during summer
    - Operate better and have screens (old windows did not have a screen)
  - Energy savings not validated by homeowner (no interest)
    - Government task if important from policy or programmatic perspective

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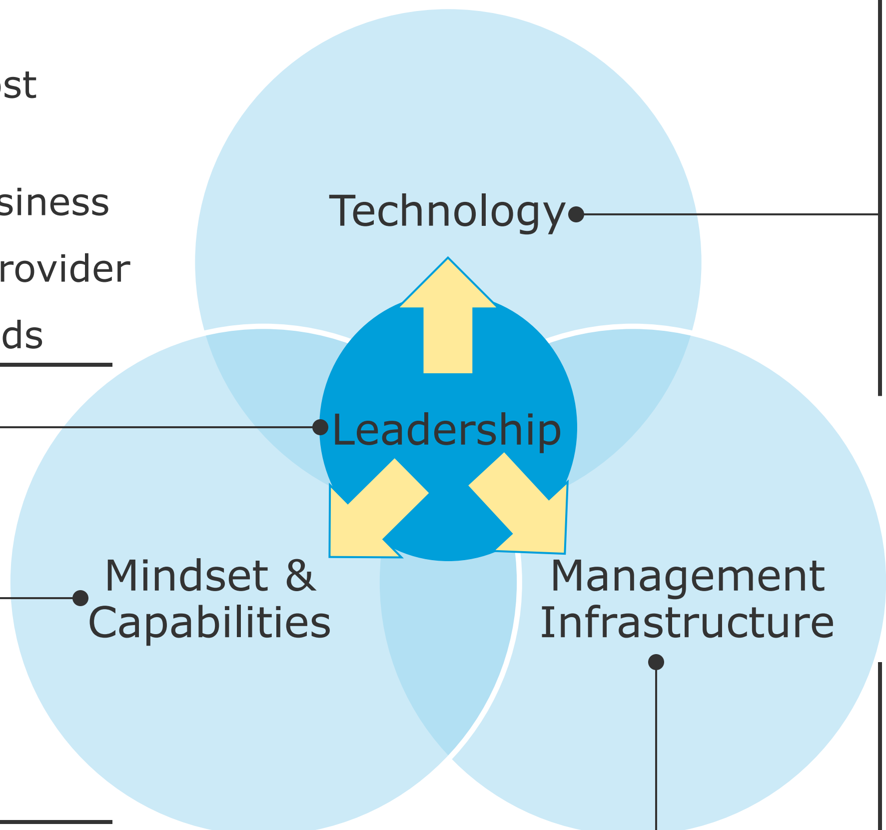
Concerns for implementation and adoption of EE projects can vary between countries and a function of leadership direction

- Short term returns vs life cycle costs
- Compliance vs cost burdens
- Focus on core business
- Trust in service provider
- Availability of funds



- Proven or right technology
- Holistic or "piece meal" technology deployment
- Quantifiable savings vis-à-vis operating conditions
- Instrumentation accuracy
- Impact on production output

- Staff training and expertise development
- Energy culture

- Energy consumption a KPI
- Availability of information
- M&V protocols
- Energy Management system
- Knowledge management

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EE barriers are relative and not absolute and need to be dealt with holistically in both developed and developing Nations (1/5)

Common technological barriers	Developing	Developed
1. Theoretical performance of equipment not always found to be demonstrated in reality	Applicable	Applicable
2. Performance, or lack thereof, in respect of EE, cannot be isolated and quantified	Applicable	Applicable
3. Lack of consensus on a holistic technological solution, therefore focus tends to be on stand alone products which individually do not achieve the same level of EE performance when not forming part of a holistic solution	Applicable	Applicable

Common cultural barriers	Developing	Developed
1. Non-economic benefits: EE is one of many attributes that the user seeks and may therefore rank lower in the user's order of priorities	Applicable	Applicable
2. Religious, ethnic or national traditions that influence energy-related behaviours	Applicable	Applicable
3. Lifestyle choices	Applicable	Applicable
4. Contextually specific practices	Applicable	Applicable

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EE barriers are relative and not absolute and need to be dealt with holistically in both developed and developing Nations (2/5)

Common organizational barriers	Developing	Developed
1. Limited capacity and staff resources to pursue EE, this means that even "low hanging fruit" is overlooked in the context of EE implementation	Applicable	Applicable
2. Production is more important than EE. Focus on production output and turnover instead of producing safely, more efficiently and reducing production costs	Applicable	Applicable
3. Market structure – dominant position of suppliers of non-EE technologies/equipment in a market may inhibit the introduction or uptake of EE equipment	More applicable	Less applicable
4. Environment, and by implication EE issues are often seen as a compliance issue and cost burden	Applicable	Applicable
5. Traditional development is linear and sequential, whereas minimising energy use requires simultaneous optimisation of an entire complex system	Applicable	Applicable
6. Dominance of near monopolistic players in the energy markets such as utilities, with little incentive to reduce demand	More applicable	Less applicable
7. Emphasis of reducing capital and not life cycle costs	Applicable	Applicable
8. Institutional bias towards supply side investment	Applicable	Applicable

EE barriers are relative and not absolute and need to be dealt with holistically in both developed and developing Nations (3/5)

Common <u>information</u> barriers	Developing	Developed
1. EE is often coupled with other costly features that cannot be separated out from the key EE features resulting in consumers paying more for features than is actually required to achieve improved EE	Applicable	Applicable
2. Imperfect information (bounded rationality): Lack, cost and accuracy of information and ability to use information	More applicable	Less applicable
3. Poor information systems: such as few meters for electricity, information held by different people, multiple sets of conflicting data for the same energy use	More applicable	Less applicable
4. Limited internal knowledge and expertise, specifically lack of training and limited written procedures/ documents	More applicable	Less applicable
5. Difficult to access external information and expertise	More applicable	Less applicable
6. Lack of standardized M&V protocol for EE savings	More applicable	Less applicable

EE barriers are relative and not absolute and need to be dealt with holistically in both developed and developing Nations (4/5)

Common economic barriers	Developing	Developed
1. High upfront capital costs – most procurement departments are required to focus on minimum procurement (upfront) costs and do not consider the lifecycle funding model	Applicable	Applicable
2. Long payback periods in respect to investment in EE equipment versus general corporate and shareholder focus on short term profits	Applicable	Applicable
3. High development costs – instead of doing a large holistic project, projects are completed in small "chunks" resulting in proportional transaction costs making the payback even more unattractive	Applicable	Applicable
4. Uncertainty of savings and perceptions of risks	Applicable	Applicable
5. Split incentives: Landlord generally unwilling to invest in higher cost EE technology when the tenant will reap the benefits of lower operational costs	More applicable	Less applicable
6. Budgets do not prioritize EE – Generally not a core mission statement so it is overlooked for other projects which demand more essential / aligned to core business	Applicable	Applicable
7. Hidden costs – There are savings when implementing EE but also M&V, maintenance and search costs to find the best EE products, technologies and methods	Applicable	Applicable

EE barriers are relative and not absolute and need to be dealt with holistically in both developed and developing Nations (5/5)

Common political barriers	Developing	Developed
1. Policies that fail to incentivise investments.	Applicable	Applicable
2. Regulated price versus marginal price. Having a fixed price or cap on tariffs to achieve other policy objectives vs EE	Applicable	Applicable
3. Lack of effective EE policies and policy inconsistency which establishes perverse, misdirected incentives	Applicable	Applicable
4. Weak enforcement of legislation; including limited funds for enforcement, bribery, stealing of electricity	Applicable	Applicable
5. Focus on short-term economic gain resulting in conflicting policies of various government bodies and agencies	Applicable	Applicable
6. Subsidies for petrol / electricity	Applicable	Applicable
7. Lack of political will to adopt policies that are unpopular	Applicable	Applicable
8. EE targets aspirational resulting in them being largely ignored	Applicable	Applicable
9. Disjointed (non-aligned) Government departments	Applicable	Applicable
10. Misunderstanding of the scale of challenges faced in EE implementation	Applicable	Applicable

Questions?

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