

September 26, 2012

# Energy Storage Computational Tool (ESCT) v1.2 Overview

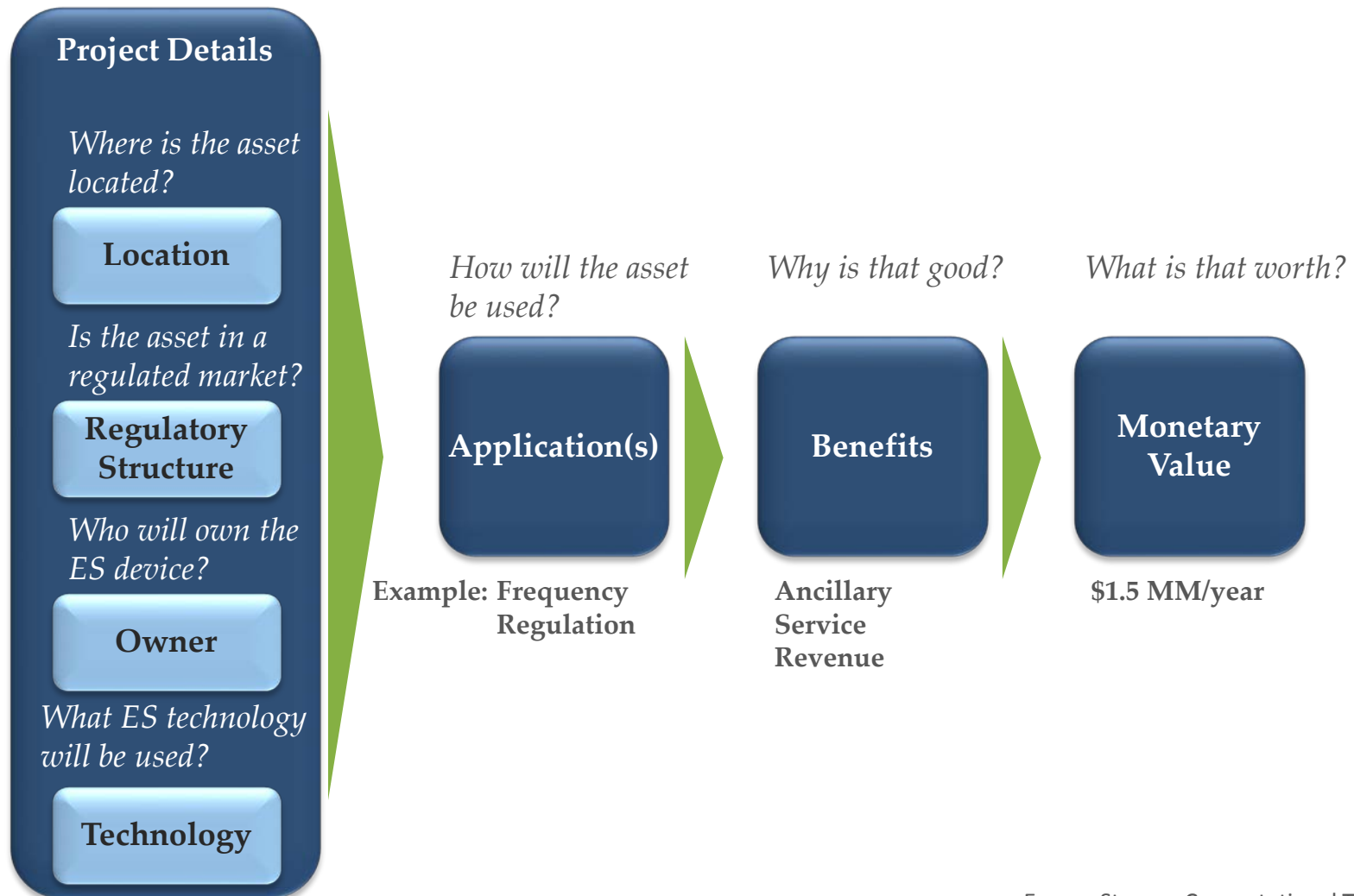
Developed under DOE Contract DE-FE0004001 Task 430.05

## The Energy Storage Computational Tool (ESCT) identifies and monetizes the costs and benefits of energy storage (ES) systems deployed in utility applications.

Characteristics of ESCT v1.2		Advantages
<b>Primary Purpose</b>	The ESCT is primarily designed to identify, quantify, and monetize the costs and benefits of an operational ES project. So, many of the inputs represent measured data.	<ul style="list-style-type: none"> <li>• Straightforward to use</li> <li>• Lends itself to quality control</li> <li>• Provides a consistent and credible method for identification and calculation of benefits</li> <li>• Ensures consistency of results across projects</li> <li>• Well suited for long term analysis</li> </ul>
<b>Secondary Purpose</b>	The ESCT can also help the user evaluate the potential costs and benefits of a proposed or hypothetical project. It could also help to optimize the size, type, and location of the ES system.	
<b>Perspective</b>	The ESCT is designed to account for all benefits including those that accrue to the asset owner, ratepayer/consumer, and societal stakeholders.	
<b>Data Inputs</b>	Measured data is used where available and estimated data is used for additional benefits that are difficult to measure or quantify.	
<b>Platform</b>	The ESCT is entirely self-contained in Microsoft Excel and can be saved, edited, and updated.	

Energy Storage Computational Tool » What framework does the ESCT use?

The tool identifies potential benefits and estimates the monetized value for an ES project based on the project details and application specified by the user.



Energy Storage Computational Tool » What framework does the ESCT use?

**Achievable benefits may vary depending on the location of the ES on the grid, the regulatory structure, the owner, and the type of technology selected.**

Project Details		
Category	Options	Definition
<b>Location</b>	Generation	This location describes any point between the generator and the transmission lines.
	Transmission	This location describes any point between the beginning of the transmission lines and the step-down distribution substation.
	Distribution	This location describes any place starting downstream of the power transformer at a step-down distribution substation, until the customer meter.
	End-User	This location describes any place on the customer-side of the customer meter.
<b>Regulatory Structure</b>	Regulated	A market in which utilities are vertically integrated, incorporating most elements of electric delivery and service into a single company.
	Deregulated	A market in which vertical integration at utilities has been broken up, allowing for independent power producers and merchant generators.
<b>Owner</b>	Utility	An asset owner that maintains and operates a local transmission and or distribution grid, such as an investor-owned utility, municipal utility, or electricity cooperative.
	Non-Utility Merchant/IPP	An asset owner that can independently deploy generation and ES assets for wholesale market participation or contracts with utilities or end users.
	End-User	An asset owner that is primarily an end-user of electricity.

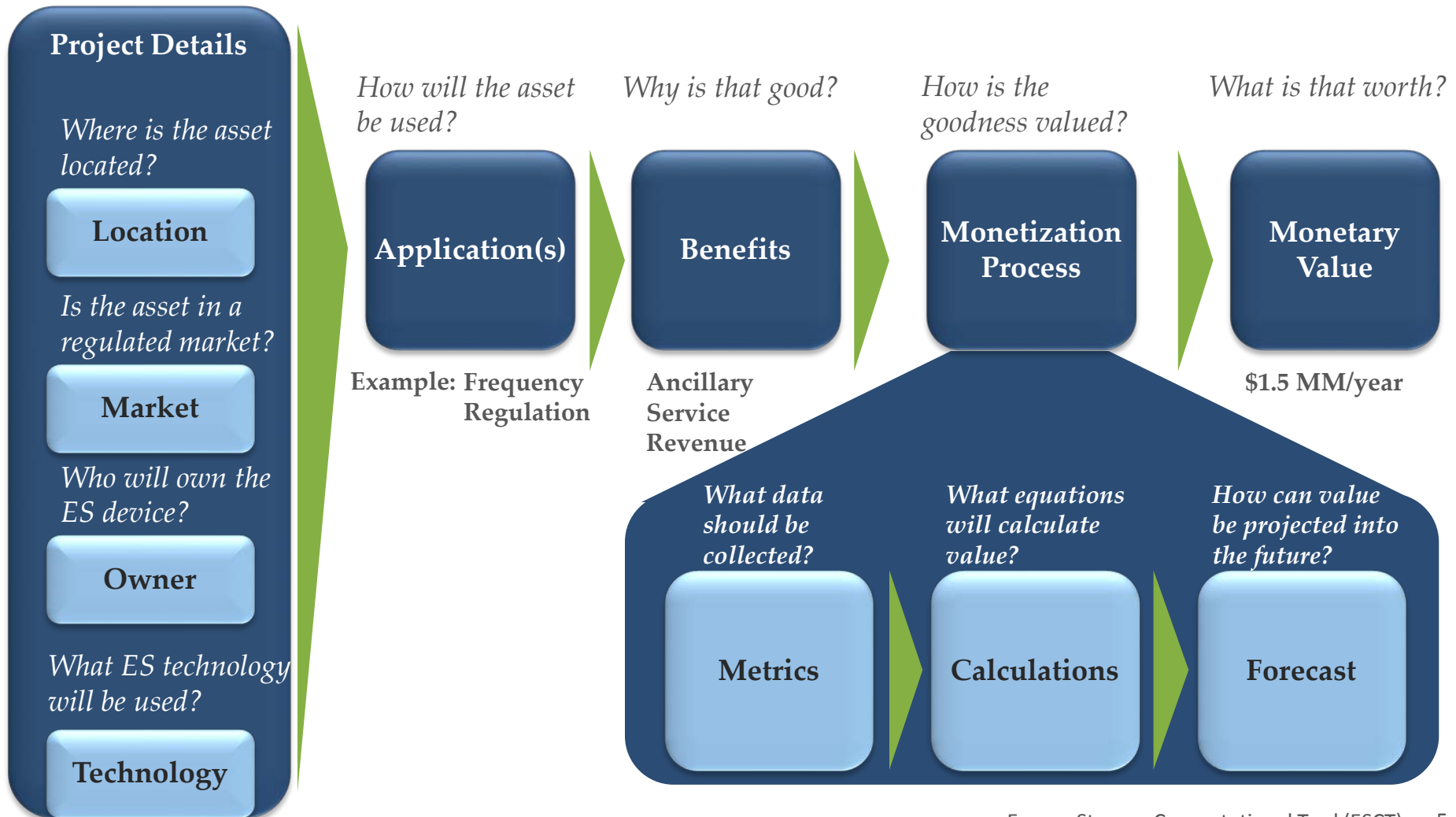
Energy Storage Computational Tool » What framework does the ESCT use?

## The ESCT identifies different benefits depending on the application selected.

Applications	Economic									Reliability		Env.		
	Market Revenue			Asset Utilization				Efficiency	Cost	Interruptions		Air		
	Arbitrage Revenue	Capacity Revenue	Ancillary Service Revenue	Optimized Generator Operation	Reduced Congestion Cost	Deferred Generation Capacity Investments	Deferred Transmission Capacity Investments	Deferred Distribution Capacity Investments	Reduced Electricity Losses	Reduced Electricity Cost	Reduced Outages	Improved Power Quality	Reduced CO <sub>2</sub> Emissions	Reduced SO <sub>x</sub> , NO <sub>x</sub> and Particulate Emissions
Electric Energy Time Shift	X			X		X	X	X	X				X	X
Electric Supply Capacity		X				X								
Load Following			X	X		X							X	X
Area Regulation			X	X		X							X	X
Electric Supply Reserve Capacity			X	X		X							X	X
Voltage Support			X									X		
Transmission Support								X			X			
Transmission Congestion Support					X			X						
T&D Upgrade Deferral				X		X	X	X					X	X
Time of Use Energy Cost Management				X		X	X	X	X				X	X
Demand Charge Management				X		X	X	X	X				X	X
Electric Service Reliability										X				
Electric Service Power Quality											X			
Renewables Energy Time Shift	X			X		X	X	X	X				X	X
Renewables Capacity Firming		X				X							X	X
Wind Generation – Short		X				X							X	X
Wind Generation – Long	X			X		X	X	X	X				X	X

Energy Storage Computational Tool » What framework does the ESCT use?

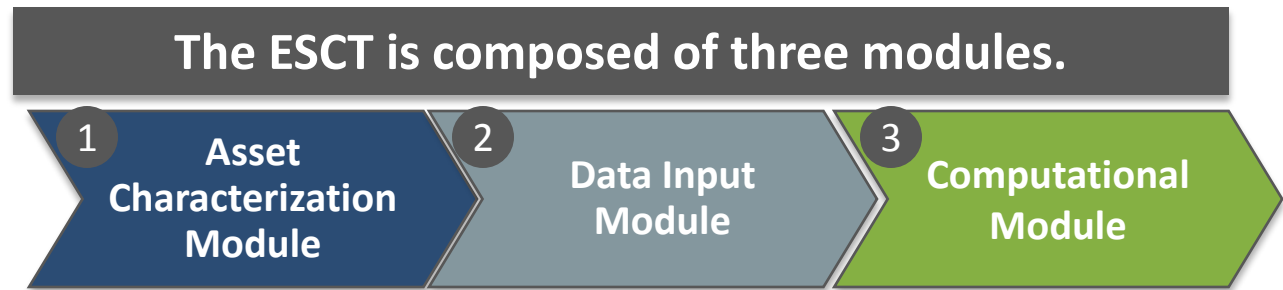
The user enters data collected during operation of the ES system in order to monetize the benefits and conduct a cost/benefit analysis over time.





Energy Storage Computational Tool » How does the ESCT work?

**ESCT modules reflect the framework developed to assess the value of an energy storage project.**



<b>Purpose</b>	Determine the list of project benefits.	Filter irrelevant metrics. Guide and assist data entry.	Calculation and present results.
<b>Inputs</b>	Project Details, Applications	List of Benefits	Calculation Dataset, Sensitivity Ranges
<b>Outputs</b>	List of Benefits	Calculation Dataset	Tabular and Graphic Presentation of Monetized Benefits
<b>Key Methodologies</b>	Application-to-Benefit Relational Models	Benefit-to-Input Relational Model	ES Benefit Calculations, Benefit Forecast Methodology

Energy Storage Computational Tool » What is the ESCT User Guide?

## **The ESCT User Guide includes detailed explanations of the methodology as well as step-by-step use instructions.**

- The first half of the User Guide is dedicated to:
  - Providing context for the tool and explaining its purpose;
  - Explaining the general methodology for assessing the benefits of an energy storage project; and
  - Defining each Application and Benefit.
- The second half of the User Guide is dedicated to:
  - Explaining the general Architecture of the ESCT; and
  - Providing a step-by-step instruction manual for using the ESCT.
- The Appendix of the User Guide documents and explains:
  - The detailed cost and benefit calculations used in the tool; and
  - Key concepts and assumptions (ex. inputs, default values, escalation techniques).



Energy Storage Computational Tool » Where can I find the ESCT?

**The ESCT, an overview presentation, and a users guide are publicly available for download at no cost at [www.SmartGrid.gov](http://www.SmartGrid.gov).**

- The ESCT and related documents can be downloaded at:

[http://www.smartgrid.gov/recovery\\_act/program\\_impacts/analytical\\_approach](http://www.smartgrid.gov/recovery_act/program_impacts/analytical_approach)

- DOE will hold webinars to demonstrate the tool to Smart Grid Demonstration Program recipients before the end of the year.

QUESTIONS??

# Key Contacts

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Asset Characterization Module Screen Shots

Location, Market, Owner, Energy Storage Technology

On this form please indicate the following:

- 1) The physical location of the energy storage deployment project,
- 2) The regulatory structure in which the storage deployment will operate in,
- 3) The owner of the storage device,
- 4) The type of storage technology the deployment utilizes.

**Location**

Generation and Transmission

Distribution

End-User

**Market**

Regulated

Deregulated

**Owner**

Utility

Non-Utility Merchant/Independent Power Producer

End-User

What type of storage technology does the deployment utilize?

Asset Characterization Module Screen Shots

**Parameters** X

Please enter all of the system parameters for the energy storage deployment.

What is the total nameplate power output (kW)?	<input type="text" value="20,000"/>	kW	<input type="button" value="Use Default Value"/>	<input type="button" value="Definition"/>
What is the total nameplate energy storage capacity (kWh)?	<input type="text" value="40,000"/>	kWh	<input type="button" value="Use Default Value"/>	<input type="button" value="Definition"/>
What is the response time of the energy storage device(s) deployed?	<input type="text" value="0.001"/>	seconds	<input type="button" value="Use Default Value"/>	
What is the nameplate round-trip efficiency of the energy storage device(s) deployed?	<input type="text" value="92"/>	%	<input type="button" value="Use Default Value"/>	
What is the nameplate cycle life (cycles) of the energy storage device(s) deployed?	<input type="text" value="1"/>	cycles	<input type="button" value="Use Default Value"/>	<input type="button" value="Definition"/>
What is the average or expected year over year demand growth of the electric system?	<input type="text" value="2"/>	%	<input type="button" value="Use Default Value"/>	
Does the energy storage device(s) deployed have reactive power capabilities?	<input type="text" value="Yes"/>		<input type="button" value="Use Default Value"/>	
Please indicate the NERC Region in which the energy storage deployment is located.	<input type="text" value="NPCC Upstate NY"/>			

Asset Characterization Module Screen Shots

**Choose First Secondary Application** X

If applicable, please choose a second secondary application for this energy storage deployment. Secondary applications describe the ways in which the energy storage unit will be used when not being used for the primary application. There are a subset of applications that are especially appropriate given the primary application being pursued and given the technical characteristics of the energy storage technology. These synergistic applications are highlighted in blue.

<input type="radio"/> Electric Energy Time-shift	<input type="button" value="Definition"/>	<input type="radio"/> Time-of-use (TOU) Energy Cost Management	<input type="button" value="Definition"/>
<input type="radio"/> Electric Supply Capacity	<input type="button" value="Definition"/>	<input type="radio"/> Demand Charge Management	<input type="button" value="Definition"/>
<input type="radio"/> Load Following	<input type="button" value="Definition"/>	<input type="radio"/> Electric Service Reliability	<input type="button" value="Definition"/>
<input type="radio"/> Area Regulation	<input type="button" value="Definition"/>	<input type="radio"/> Electric Service Power Quality	<input type="button" value="Definition"/>
<input type="radio"/> Electric Supply Reserve Capacity	<input type="button" value="Definition"/>	<input checked="" type="radio"/> Renewables Energy Time-shift	<input type="button" value="Definition"/>
<input checked="" type="radio"/> Voltage Support	<input type="button" value="Definition"/>	<input type="radio"/> Renewables Capacity Firming	<input type="button" value="Definition"/>
<input type="radio"/> Transmission Support	<input type="button" value="Definition"/>	<input type="radio"/> Wind Generation Grid Integration - Short Duration	<input type="button" value="Definition"/>
<input type="radio"/> Transmission Congestion Relief	<input type="button" value="Definition"/>	<input checked="" type="radio"/> Wind Generation Grid Integration - Long Duration	<input type="button" value="Definition"/>
<input checked="" type="radio"/> Transmission & Distribution (T&D) Upgrade Deferral	<input type="button" value="Definition"/>	<input type="radio"/> No Secondary Applications	
<input type="radio"/> Substation On-site Power	<input type="button" value="Definition"/>		

Asset Characterization Module Screen Shots

Back

**Benefits** X

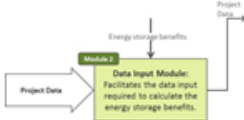
The benefits highlighted in blue below represent the benefits that your energy storage project will yield based on primary and secondary applications that are being pursued. For further explanation of a benefit click the button to the right of the benefit.

<table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 80%;">Arbitrage Revenue</td><td style="text-align: center;">Definition</td></tr> <tr><td>Capacity Market Revenue</td><td style="text-align: center;">Definition</td></tr> <tr><td>Ancillary Services Revenue</td><td style="text-align: center;">Definition</td></tr> <tr><td>Reduced Electricity Cost (Consumer)</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced Electricity Cost (Utility/Ratepayer)</td><td style="text-align: center;">Definition</td></tr> <tr><td>Reduced Congestion Costs (Non-Utility Merchant)</td><td style="text-align: center;">Definition</td></tr> <tr><td>Reduced Congestion Costs (Utility/Ratepayer)</td><td style="text-align: center;">Definition</td></tr> <tr><td>Optimized Generator Operation (Non-Utility Merchant)</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Optimized Generator Operation (Utility/Ratepayer)</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced Electricity Losses</td><td style="text-align: center;">Definition</td></tr> </table>	Arbitrage Revenue	Definition	Capacity Market Revenue	Definition	Ancillary Services Revenue	Definition	Reduced Electricity Cost (Consumer)	Definition	Reduced Electricity Cost (Utility/Ratepayer)	Definition	Reduced Congestion Costs (Non-Utility Merchant)	Definition	Reduced Congestion Costs (Utility/Ratepayer)	Definition	Optimized Generator Operation (Non-Utility Merchant)	Definition	Optimized Generator Operation (Utility/Ratepayer)	Definition	Reduced Electricity Losses	Definition	<table style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 80%;">Deferred Transmission Investments</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Deferred Distribution Investments</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Deferred Generation Capacity Investments</td><td style="text-align: center;">Definition</td></tr> <tr><td>Reduced Outages (Consumer)</td><td style="text-align: center;">Definition</td></tr> <tr><td>Reduced Outages (Utility/Ratepayer)</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Improved Power Quality</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced CO2 Emissions</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced SOx Emissions</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced NOx Emissions</td><td style="text-align: center;">Definition</td></tr> <tr style="background-color: #007bff; color: white;"><td>Reduced PM Emissions</td><td style="text-align: center;">Definition</td></tr> </table>	Deferred Transmission Investments	Definition	Deferred Distribution Investments	Definition	Deferred Generation Capacity Investments	Definition	Reduced Outages (Consumer)	Definition	Reduced Outages (Utility/Ratepayer)	Definition	Improved Power Quality	Definition	Reduced CO2 Emissions	Definition	Reduced SOx Emissions	Definition	Reduced NOx Emissions	Definition	Reduced PM Emissions	Definition
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Previous
Finish



Data Input Module Screen Shots



**Data Input Module**  
Facilitates the data input required to calculate the energy storage benefits.

Project Charge

### Data Input Module

Use the table below to enter the project data that will be used to calculate benefits. For each input the more exact value data for at least one project year before being able to submit values and complete this step. However, all data has been entered with the blue button at the bottom of the table to submit and save the data entries. If getting data from another source into this table please use the "Paste Value" function to avoid copying and pasting or getting formulas. If the more data will have measured data to enter, then use average default values for most of the inputs. However, if all default values are used the more should take care in interpreting the results since the default values tend to be general estimates, and the actual values for the user's project may vary greatly. Furthermore, default values do not take into account situations in which energy storage deployments are being used for multiple applications, rather they assume the storage is being used for a single application for a entire year. Therefore, if multiple applications are being pursued and default values are being used, the more exact values (that the default) amount of energy discharge for each application is realistic considering that the storage is being used for more than one application throughout the year.

Return to the Asset Characterization Module (ACM)

Input Name	Units	Input Definition	Default Values	Value				
				100	105	102	103	104
Total Energy Discharged for Arbitrage	MWh	The total amount of energy discharged from the storage storage device and used for arbitrage purposes over a year.	Enter Coales					
Total Energy Discharged for Energy Time Shift	MWh	The total amount of energy discharged from the storage storage device for the purpose of shifting storage from an off-peak time to an on-peak time. This may allow a utility to decrease their costs by shifting the need to run from off-peak, more expensive, generation units.	Enter Coales					
Storage Variable Peak Generation Costs	\$/MWh	The storage variable generation costs for marginal generation units used to meet peak demand.	Enter Coales					
Storage Variable Off-Peak Generation Costs	\$/MWh	The storage variable generation costs for base load generation units.	Enter Coales					
CO2 Emissions Factor for Generation in the Margin	lbs/MWh	The characteristics or average CO2 emissions factor for marginal generation units used to meet peak demand.	Enter Coales					
CO2 Emissions Factor for Base Generation	lbs/MWh	The characteristics or average CO2 emissions factor for base load generation units.	Enter Coales					
SOx Emissions Factor for Generation in the Margin	lbs/MWh	The characteristics or average SOx emissions factor for marginal generation units used to meet peak demand.	Enter Coales					
SOx Emissions Factor for Base Generation	lbs/MWh	The characteristics or average SOx emissions factor for base load generation units.	Enter Coales					
NOx Emissions Factor for Generation in the Margin	lbs/MWh	The characteristics or average NOx emissions factor for marginal generation units used to meet peak demand.	Enter Coales					
NOx Emissions Factor for Base Generation	lbs/MWh	The characteristics or average NOx emissions factor for base load generation units.	Enter Coales					
PM Emissions Factor for Generation in the Margin	lbs/MWh	The characteristics or average PM emissions factor for marginal generation units used to meet peak demand.	Enter Coales					
PM Emissions Factor for Base Generation	lbs/MWh	The characteristics or average PM emissions factor for base load generation units.	Enter Coales					
Value of CO2	\$/ton	The anticipated or current market price of carbon emissions.	Enter Coales					
Value of SOx	\$/ton	The anticipated or current market price of SOx.	Enter Coales					
Value of NOx	\$/ton	The anticipated or current market price of NOx.	Enter Coales					
Value of PM	\$/ton	The anticipated or current market price of PM.	Enter Coales					
Capital Cost of Coordinated Voltage Support Solution	\$/MVAR	The amount of money that would be required to fix a reactive power issue that is causing power quality issues using a non-traditional solution. This value will be used as a proxy to measure the power quality benefit provided by the storage storage solution.	Enter Coales					
Maximum Reactive Power Capacity of Energy Storage	MVAR	The total reactive power output capacity of the distributed energy storage solution. This reactive power output capability of distributed energy storage devices could be used in the voltage support application to provide reactive power and manage voltage thereby increasing better power quality and reliability.	Enter Coales					
Annual Fixed Charge Rate for Voltage Support Capital Investment	X	The rate used to measure the capital cost of an installed non-traditional voltage support solution into an existing equivalent (or equal) representing annual carrying charges for capital equipment. It includes consideration of interest and equity return rates, annual internal operations and value of debt principal, dividends and return of equity principal, income taxes, and property taxes.	Enter Coales					

END

Finish Data Entry

Introduction
Application Benefits Summary
**Data Input Module**

Back

## Data Input Module

Use the table below to enter the project data that will be used to calculate benefits. For each input the user must enter data for at least one project year before being able to submit values and complete this step. When all data has been entered click the blue button at the bottom of the table to submit and save the data entries. If pulling data from another source into this table please use the "Paste Value" function to avoid copying cell formulas or pulling formulas. If the user does not have measured data to enter, they can leverage default values for most of the inputs. However, if default values are used the user should take care in interpreting the results since the default values tend to be general estimates, and the actual values for the user's project may vary greatly. Furthermore, default values do not take seasonal situations in which storage charge deployments are being used for multiple applications, rather they assume the storage is being used for a single application for an entire year. Therefore, if multiple applications are being pursued and default values are being used, the user must ensure that the default amount of energy discharge for each application is realistic considering that the storage is being used for more than one application throughout the year.

[Return to the Asset Characterization Module \(ACM\)](#)

Input Name	Units	Input Definition	Default Values	Value				
				100	101	102	103	104
Total Energy Discharged for Arbitrage	MWh	The total amount of energy discharged from the energy storage device and used for arbitrage purposes over a year.	Enter Cost					
Total Energy Discharged for Energy Time Shift	MWh	The total amount of energy discharged from the energy storage device for the purpose of shifting energy from						
Average Variable Peak Generation Costs	\$/MWh							
Average Variable Off-Peak Generation Costs	\$/MWh							
CO2 Emissions Factor for Generation with Storage	lb/MWh							
CO2 Emissions Factor for Base Generation	lb/MWh							
SOx Emissions Factor for Generation with Storage	lb/MWh							
SOx Emissions Factor for Base Generation	lb/MWh							
NOx Emissions Factor for Generation with Storage	lb/MWh							
NOx Emissions Factor for Base Generation	lb/MWh							
PM Emissions Factor for Generation with Storage	lb/MWh							
PM Emissions Factor for Base Generation	lb/MWh							
Value of CO2	\$/ton							
Value of SOx	\$/ton							
Value of NOx	\$/ton							
Value of PM	\$/ton							
Capital Cost of Commercial Voltage Support Solution	\$/MVAR							
Example: Real-time Power Capacity of Energy Storage	MVAR	The total real-time power output capacity of the distributed energy storage solution. This real-time power output capacity of distributed energy storage devices would be used in the voltage support application to provide real-time power and manage voltage thereby ensuring better power quality and reliability.	Enter Cost					
Annual Fixed Charge Rate for Voltage Support Capital Investment	X	The rate used to measure the capital cost of an installed commercial voltage support solution into an existing equivalent (or new) representing annual carrying charges for capital equipment. It includes consideration of interest and equity return rates, annual interest payments and value of debt principal, dividends and return of equity principal, income taxes, and property taxes.	Enter Cost					

[Finish Data Entry](#)

Introduction
Application Benefits Summary
Data Input Module

Microsoft Excel

Please make sure you enter data for at least one year for all required inputs. All of the required data for the Total Energy Discharged for Arbitrage input is not entered. If the value for a particular year is zero please enter zero rather than leaving the space blank. Do not enter zero for project data beyond the first year if data is simply unavailable however.

OK

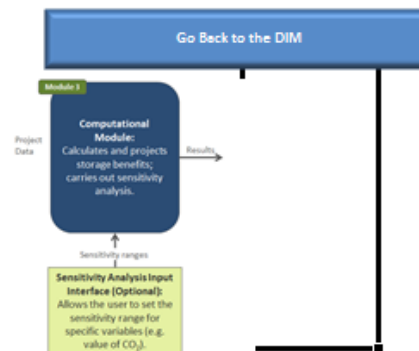
## Computational Module (CM) Main Page

### Instructions

Welcome to the Computational Module (CM) phase of the Energy Storage Computational Tool (ESCT). The CM is the calculation engine of the tool, it crunches the numbers and generates the output. The CM also allows the user to complete a sensitivity analysis if desired.

Running the CM with Reference Inputs - To run the CM with the inputs that were entered in the DIM phase, simply click the button in the "Reference Case" section that says "Run CM with Reference Case Inputs". The CM will take about 20 seconds to complete the analysis. Once the analysis is complete the results can be viewed by clicking the "View Reference Case Results" button.

Running the a Sensitivity Analysis - Before running a sensitivity analysis the CM should be run with the reference case inputs by following the directions above. To run a sensitivity analysis first change the High and Low sensitivity ranges of the desired inputs by using the toggles that are to the right of every input. After all of the desired sensitivity ranges have been set click the button in the "Sensitivity Analysis" section that says "Run CM with Sensitivity Case Inputs". The CM will take about a 40 seconds to complete the analysis.



### Reference Case

Run CM with Reference Case Inputs

View Reference Case Results

### Sensitivity Analysis

Run CM with Sensitivity Case Inputs

View Sensitivity Results

Reset all values to 100%

Input Name	Unit	Select % using toggle			2011 Value		
		Low	Referenc	High	Low	Reference	High
Total Energy Discharged for Arbitrage	MWh	100%	100%	100%	\$ 18,000	\$ 18,000	\$ 18,000
Total Energy Discharged for Energy Time-Shift	MWh	100%	100%	100%	18,000	18,000	18,000
Average Variable Peak Generation Costs	\$/MWh	100%	100%	100%	\$ 46	\$ 46	\$ 46
Average Variable Off-Peak Generation Costs	\$/MWh	100%	100%	100%	\$ 24	\$ 24	\$ 24
CO2 Emissions Factor for Generation on the Margin	lbs/MWh	100%	100%	100%	845	845	845
CO2 Emissions Factor for Base Generation	lbs/MWh	100%	100%	100%	-	-	-
SOx Emissions Factor for Generation on the Margin	lbs/MWh	100%	100%	100%	0.075	0.075	0.075
SOx Emissions Factor for Base Generation	lbs/MWh	100%	100%	100%	-	-	-
NOx Emissions Factor for Generation on the Margin	lbs/MWh	100%	100%	100%	0.25	0.25	0.25
NOx Emissions Factor for Base Generation	lbs/MWh	100%	100%	100%	-	-	-
PM Emissions Factor for Generation on the Margin	lbs/MWh	100%	100%	100%	0.040	0.040	0.040
PM Emissions Factor for Base Generation	lbs/MWh	100%	100%	100%	0.200	0.200	0.200
Value of CO2	\$/ton	100%	100%	100%	\$ 20	\$ 20	\$ 20

Computational Module Screen Shots

**Reference Case Output: Annual and Cumulative Results Tables**

The tables below display the annual and cumulative project benefits and costs. The benefits are organized by category. The total gross benefit, total cost, and net benefit are also displayed at the bottom of each chart. All values are present value terms. To calculate additional benefits navigate to the additional benefits worksheets from the Additional Benefits tab.

Annual Benefit and Cost Table		Primary and Secondary Benefits - Total Present Value over the Deployment Period		Total Benefit - Present Value over the Deployment Period	2011	2012	2013	2014	2015
Benefits		Additional Benefits - Total Present Value over the Deployment Period	+	=					
Market Revenue	Arbitrage Revenue	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Capacity Market Revenue	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Ancillary Services Revenue	\$ -	\$ 44,855,400	\$ 44,855,400	\$ 5,303,900	\$ 5,038,700	\$ 4,786,700	\$ 4,547,400	\$ 4,320,000
Improved Asset Utilization	Optimized Generator Operation (Non-Utility Merchant)	\$ -	\$ 154,200	\$ 154,200	\$ 18,200	\$ 17,300	\$ 16,500	\$ 15,600	\$ 14,900
	Optimized Generator Operation (Utility/Ratepayer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Deferred Generation Capacity Investments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced Congestion Costs (Non-Utility)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
T&D Capital Savings	Reduced Congestion Costs (Utility/Ratepayer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Deferred Transmission Investments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Energy Efficiency	Deferred Distribution Investments	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced Electricity Losses	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Electricity Cost Savings	Reduced Electricity Cost (Consumer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced Electricity Cost (Utility/Ratepayer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Power Interruptions	Reduced Outages (Consumer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced Outages (Utility/Ratepayer)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Power Quality	Improved Power Quality	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced CO2 Emissions	\$ -	\$ 216,500	\$ 216,500	\$ 25,600	\$ 24,300	\$ 23,100	\$ 21,900	\$ 20,900
Air Emissions	Reduced SOx Emissions	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
	Reduced NOx Emissions	\$ -	\$ 27,900	\$ 27,900	\$ 3,300	\$ 3,100	\$ 3,000	\$ 2,800	\$ 2,700
	Reduced PM Emissions	\$ -	\$ 12,100	\$ 12,100	\$ 1,400	\$ 1,400	\$ 1,300	\$ 1,200	\$ 1,200
<b>Total Gross Benefit</b>		<b>\$ -</b>	<b>\$ 45,266,100</b>	<b>\$ 45,266,100</b>	<b>\$ 5,352,400</b>	<b>\$ 5,084,800</b>	<b>\$ 4,830,600</b>	<b>\$ 4,588,900</b>	<b>\$ 4,359,700</b>
<b>Costs</b>									
Capital Cost of Deployment (fixed charge rate)				\$ 19,156,400	\$ 2,387,000	\$ 2,267,700	\$ 2,154,300	\$ 2,046,600	\$ 1,944,200
Operating and maintenance costs not related to energy (labor for operation, plant maintenance, equipment wear leading to loss-of-life)				\$ 1,283,900	\$ 160,000	\$ 152,000	\$ 144,400	\$ 137,200	\$ 130,300
Decommissioning and Disposal Costs				\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
<b>Total Annual Cost of Deployment</b>				<b>\$ 20,440,300</b>	<b>\$ 2,547,000</b>	<b>\$ 2,419,700</b>	<b>\$ 2,298,700</b>	<b>\$ 2,183,700</b>	<b>\$ 2,074,500</b>
<b>Total Net Benefit</b>				<b>\$ 24,825,800</b>	<b>\$ 2,805,400</b>	<b>\$ 2,665,100</b>	<b>\$ 2,531,900</b>	<b>\$ 2,405,200</b>	<b>\$ 2,285,200</b>

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