



Efficiency
Valuation
Organization

RENEWABLES APPLICATION GUIDE

INTERNATIONAL PERFORMANCE
MEASUREMENT AND VERIFICATION
PROTOCOL

March 2017

EVO 10200 – 1:2017

RENEWABLES APPLICATION GUIDE

INTERNATIONAL PERFORMANCE
MEASUREMENT AND VERIFICATION
PROTOCOL

March 2017

EVO 10200 – 1:2017

Efficiency Valuation Organization (EVO)

EVO is a non-profit organization whose products and services help people implement and invest in energy efficiency projects worldwide. **EVO's Vision** is to create a world that has confidence in energy efficiency as a reliable and sustainable energy resource. **EVO's Mission** is to ensure that the savings and impact of energy efficiency and sustainability projects are accurately measured and verified.

EVO Board of Directors

Thomas K. Dreessen , Chair	(USA)	EPS Capital
Pierre Langlois , Vice Chair	(Canada)	Econoler
Robert Dixon , Secretary	(USA)	Siemens
Neil Salisbury , Treasurer	(Australia)	Point Advisory
Anees Iqbal	(UK)	Maicon Associates Ltd.
Patrick Jullian	(France)	IFS2E
Stephane LeGentil	(UAE)	Etihad Energy Services Company
Mark Lister	(Denmark)	Copenhagen Center on Energy Efficiency

The International Performance Measurement and Verification Protocol (IPMVP®) is the leading international protocol for measurement and verification maintained by EVO. It is updated with the help of EVO's IPMVP Committee, a group of industry professionals who volunteer their time and for whom we are indebted for developing this edition of the *2016 IPMVP® Core Concepts*.

IPMVP Committee 2016

Tracy Phillips , Chair	(USA)	7 th Gen Energy Solutions
Maggie Selig , Vice Chair	(USA)	Celtic Energy
Jan Bleyl	(Austria)	Energetic Solutions
Jim Bradford	(USA)	Mesa Point Energy
Luis Castanheira	(Portugal)	Energaia
Shankar Earni	(USA)	Lawrence Berkeley National Laboratory
Ellen Franconi	(USA)	Rocky Mountain Institute
David Jump	(USA)	QuEST
Sami Khawaja	(USA)	Cadmus Group Inc.
Bill Koran	(USA)	SBW Consulting
David Korn	(USA)	Cadmus Group Inc.
Ken Lau	(Canada)	BC Hydro
Christian Lemieux	(Canada)	Econoler
Christophe Rodriguez	(France)	EDF Optimal Solutions
Shawn Shaw	(USA)	Cadmus Group Inc.
Kevin Warren	(USA)	Warren Energy Engineering
Lia Webster	(USA)	CLEAResult
Hillary Wood	(England)	EEVS

Renewables Subcommittee

Shawn Shaw , Chair	(USA)	Cadmus Group Inc.
Maggie Selig	(USA)	Celtic Energy
Andy Walker	(USA)	National Renewable Energy Laboratory
Mary Knipe	(USA)	Cadmus Group Inc.

Introduction to 2016 IPMVP Core Concepts Application Guides

The *2016 International Performance Measurement and Verification Protocol (IPMVP®) Core Concepts* defines basic terminology used in the Measurement and Verification (M&V) field and the general procedures to achieve reliable and cost-effective determination of savings. Verification of actual savings is performed relative to an M&V Plan for each project. The Core Concepts document is written for general application in measuring and verifying the performance of projects which improve energy or water efficiency in buildings and industrial plants.

The IPMVP Committee has undertaken the development and revision of several accompanying Application Guides. This document includes M&V options for renewable energy systems within the IPMVP framework, and includes examples and recommendations for specific applications. Renewable energy technologies include solar, wind, biomass, geothermal, small hydroelectric, ocean thermal, wave and tidal energy.

In the coming months, similar Application Guides will be published for:

- » ***Statistics and Uncertainty.*** Describes methods to manage and quantify uncertainty due to random and systematic errors that result from quality of the measurement equipment, the measurement techniques, and the design sampling procedure.
- » ***M&V Applications.*** Presents a variety of project types and discusses the key M&V design issues arising from the described situations. Each example shows just one IPMVP adherent M&V design, though there are numerous possible designs for any project.

If you have any questions regarding the information in these documents, please contact us at EVO.central@evo-world.org.

Table of Contents

1. Introduction: Renewables	1
1.1. Overview.....	1
1.2. Scope and Purpose	2
1.3. Intended Audience	2
1.4. References to IPMVP Core Document.....	4
2. General Guidance on Operational and Savings Verification for Renewable Energy Systems	5
2.1. Operational Verification	5
2.2. Savings Verification	7
3. Renewable Energy Application of IPMVP Options	15
3.1. Option A: Retrofit-Isolation, Key Parameter Measurement	15
3.2. Option B: Retrofit-isolation, All Parameter Measurement	15
3.3. Option C: Whole Facility	19
3.4. Option D: Calibrated Simulation.....	21
4. Guidelines for M&V Applications	24
4.1. Programmatic Applications	24
5. Costs & Benefits	26