IEA Task 14
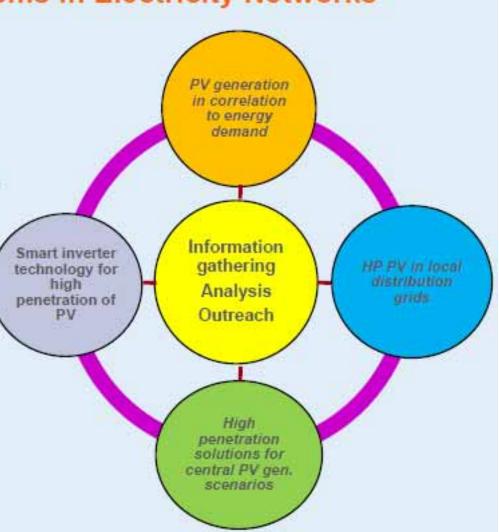# High Penetration Photovoltaics Workshop

December 1, 2010
Golden, Colorado

Hosted by DOE, NREL and SEPA

IEA PVPS – Task 14
High Pentration of PV Systems in Electricity Networks

> PV generation in correlation to energy demand focusing on the consumer behavior to be better linked to the generation profile

> The effects on PV generation to the local grid as well as to the general electricity system

> Smart inverter technology dealing with requirements for inverters at high PV penetration

> Convincing case studies, Simulation

PVPS

PV generation in correlation to energy demand

Smart inverter technology for high penetration of PV

Information gathering Analysis Outreach

HP PV in local distribution grids

High penetration solutions for central PV gen. scenarios

Overall Goal of this international collaboration

➤ **Promote the use of grid connected PV** as an important source in electric power systems **also on a high penetration level** where additional efforts may be necessary to integrate the dispersed generators in an optimum manner.

➤ Develop and verify **mainly technical requirements for PV systems and electric power systems** to allow for high penetrations of PV systems interconnected with the grid

➤ Discuss the **active role of PV systems** related to energy management and system control of electricity grids

PVPS

Added value (I)

Bringing together **experts from different countries worldwide** to jointly analyze the scenarios of high penetration PV based on their own practical and theoretical experiences.

Main goal is to **provide access to more transparent technical analyses** in order for industry, network operators, energy planners as well as authorities in the energy business to decide on steps to be taken and strategies to be developed on a sound basis.

PVPS

Added value (II)

This activity will contribute to a common understanding and a broader consensus on how to adequately evaluate the value of PV in high penetration by

➢ Showing the **full potential of grid integrated photovoltaics**,

➢ Easy access to the main findings of the reports are expected **to mitigate concerns** of high penetration PV to the benefit of a large number of countries.

➢ to provide **comprehensive international studies for high penetration PV**

➢ The highly accepted **dissemination tools of IEA PVPS** will make it easy to disseminate the results from the Task 14 activities.

PVPS

Penetration Definitions

At least three different measures are used to describe penetration levels: energy penetration, capacity penetration, and instantaneous penetration. They are defined and related as follows:

Energy penetration is the ratio of the amount of energy delivered from the generation to the total energy delivered. For example, if 200 megawatt-hours (MWh) of energy is supplied and 1,000 MWh is consumed during the same period, energy penetration is 20%.

Capacity penetration is the ratio of the nameplate rating of the plant capacity to the peak load. For example, if a 300-MW plant is operating in a zone with a 1,000-MW peak load, the capacity penetration is 30%. The capacity penetration is related to the energy penetration by the ratio of the system load factor to the plant capacity factor. If the system load factor is 60% and the plant capacity factor is 40%. In this case, and with an energy penetration of 20%, the capacity penetration would be 20% × 0.6/0.4, or 30%.

Instantaneous penetration is the ratio of the plant output to load at a specific point in time, or over a short period of time.

High Penetration Survey

Parameter	Value	Notes
Feeder Name		
Feeder Number		
Substation Transformer Size (MVA)		
Transmission Voltage (Primary) (kV)		
Feeder Voltage (Secondary) (kV)		
Peak Load (MW)		
Minimum Daytime Load (MW) if available		
System Fault Current at Substation		
Feeder conductor rating (A) – main size		
Voltage regulation type		
Voltage regulation location		
Reclosers on feeder, setting if available		
Any other DG on Feeder? Size?		
Reverse power flow capability of transformer		
Number of other circuits on substation		

High Penetration Survey

Parameter	Value	Notes
Installed PV Capacity (MWac)		
Fault Current from PV (kA)		
Zero sequence impedance of DG ground source		
Distance from Substation (miles)		
Available Fault Current at PV location		
Impedance of circuit at PV location		
Utility ground source impedance		
Transfer trip on PV?		

Agenda

- 10:00-10:30 - Workshop Intro, Ben and Christy

US High Penetration Examples

- 10:30-11:00 - Xcel Energy, Dave Baca
- 11:00-11:30 - PEPCO, Ryan Sherwood and Alex Dinkel
- 11:30-12:00 - HELCO, Lisa Dangelmaier

- 12:00 – 1:00 Lunch

Agenda

International High Penetration Examples

- 13:00-13:30   - Germany, Martin Braun
- 13:30-14:00 - Austria, Christoph Mayr
- 14:00-14:30 - Denmark, Kenn Frederiksen
- 14:30-15:00 - Japan, Kazuhiko Ogimoto