



IEA Solar Power and Chemical Energy Systems

Solar PACES



SolarPACES



Prof. Robert Pitz-Paal
SolarPACES Acting Chair
April 7, 20110
Vienna , Austria

What is the IEA?



- Established in November 1974
- Objectives:
 - ✓ Reduce dependence on oil
 - ✓ Increase energy efficiency
 - ✓ Conserve energy resources
 - ✓ Develop coal, natural gas, nuclear power, and renewables
- 26 member countries
- 40 international cooperative agreements including:
 - SolarPACES
 - Photovoltaic Power Systems
 - Solar Heating and Cooling
 - Wind Energy Systems
 - Ocean Energy Systems
 - Bioenergy



SolarPACES Countries

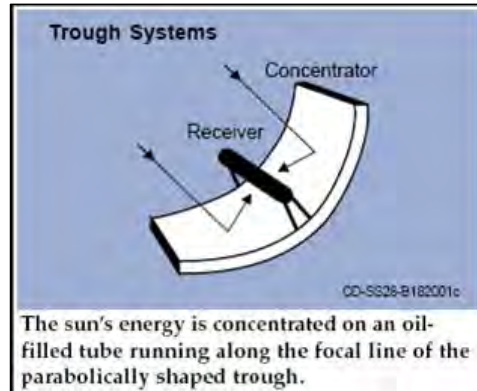
Interested: India, Portugal, Greece, Turkey, Jordan, and Chile



SolarPACES

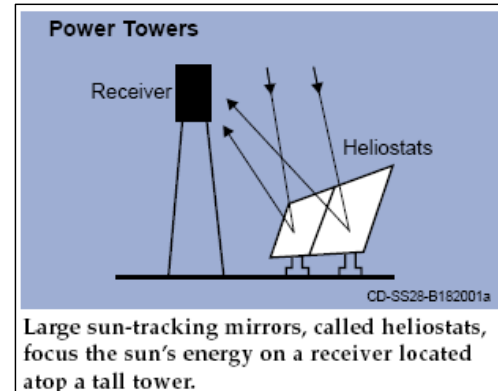


Concentrator Optics



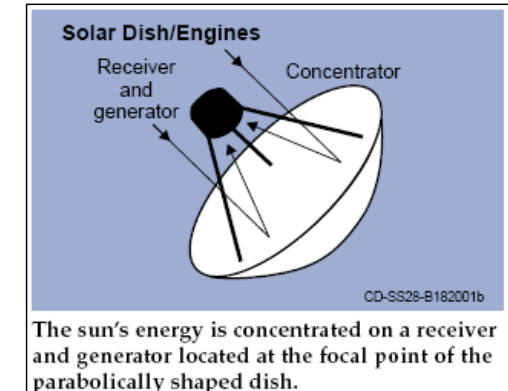
Linear Concentrator

- Parabolic 2-D shape
- Focal Length ~ 3m
- Tracks E to W
- CR ~ 30 to 40
- Fresnel reflector may be utilized



Point-Focus Central

- Parabolic 3-D shape
- Heliostats track in azimuth and elevation
- Focal Length ~ 100sm
- CR ~ 800



Point-Focus Distributed

- Parabolic 3-D shape
- Tracks on Sun in azimuth and elevation
- Focal Length ~ 4 m
- CR ~ 3000



SolarPACES

Parabolic Trough Technologies

SEGS (US 1985 – 1991) Nevada Solar One (US 2007) Andasol (Spain 2009)



Nominal capacity: 354 MW
Constructed 1985 - 1991
9 Sites in California
Hybrid for dispatch (25%)
Total reflect area > 2.3 Mill. m²
More than 117,000 HCEs
30 MW increment based on regulated power block size

Nominal capacity: 64 MW
Construction In 16 months
250 Acre solar field
30 minutes of TES
Capital invest: \$266 million
105% of planned performance
for the first 18 months of operation

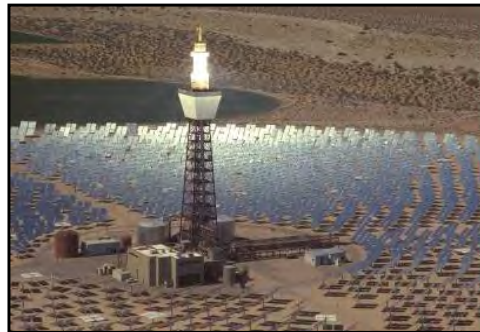
Nominal Capacity: 44.9 MW
Two-Tank Molten-Salt Storage
7 full-load hours of storage
Capital Investment: 260 mi€
549,380 m² of trough collectors
28,500 tonnes of molten salt



Power Tower Technologies



**Solar Two Experiment
(1996 – 1999) US**



10 MW Capacity
 Molten Salt WF/TES
 Receiver $\eta = 88\%$
 η of Storage > 98%
 Dispatchability
 demonstrated

**PS 10 (2007)
 PS 20 (2009) Spain**



11 MW & 20 MW Capacity
 Once-through steam boiler
 1 Hour TES (steam)
 1878 helios (120 m² each)
 Tower height 100m/ 160m
 73 GWhr/annually

**SEDC Demo
(2008) Israel**



5 MWt Capacity
 Direct Solar-to-
 Steam
 High Temp. 550° C
 Flat Glass Mirrors
 Air Cooled
 60 m receiver tower
 1,641 helists (7 m²)

**Sierra Demo
(2009) US**



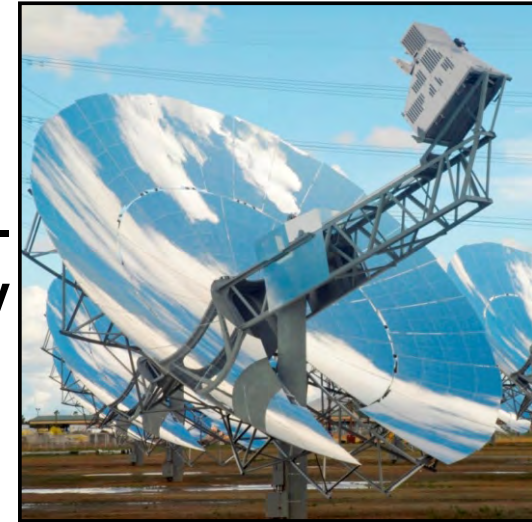
5 MW Demonstration
 Plant (two towers)
 46-MW Standard
 module (16 towers)
 Small, flat mirrors
 Unique heliostat
 control system



CSP Dish Stirling Systems



Utility-Scale System:
25 kW system
Peak (net solar-to-electric) efficiency 31.25%
Autonomous operation



Distributed Generation System:
10 kW system
Autonomous operation

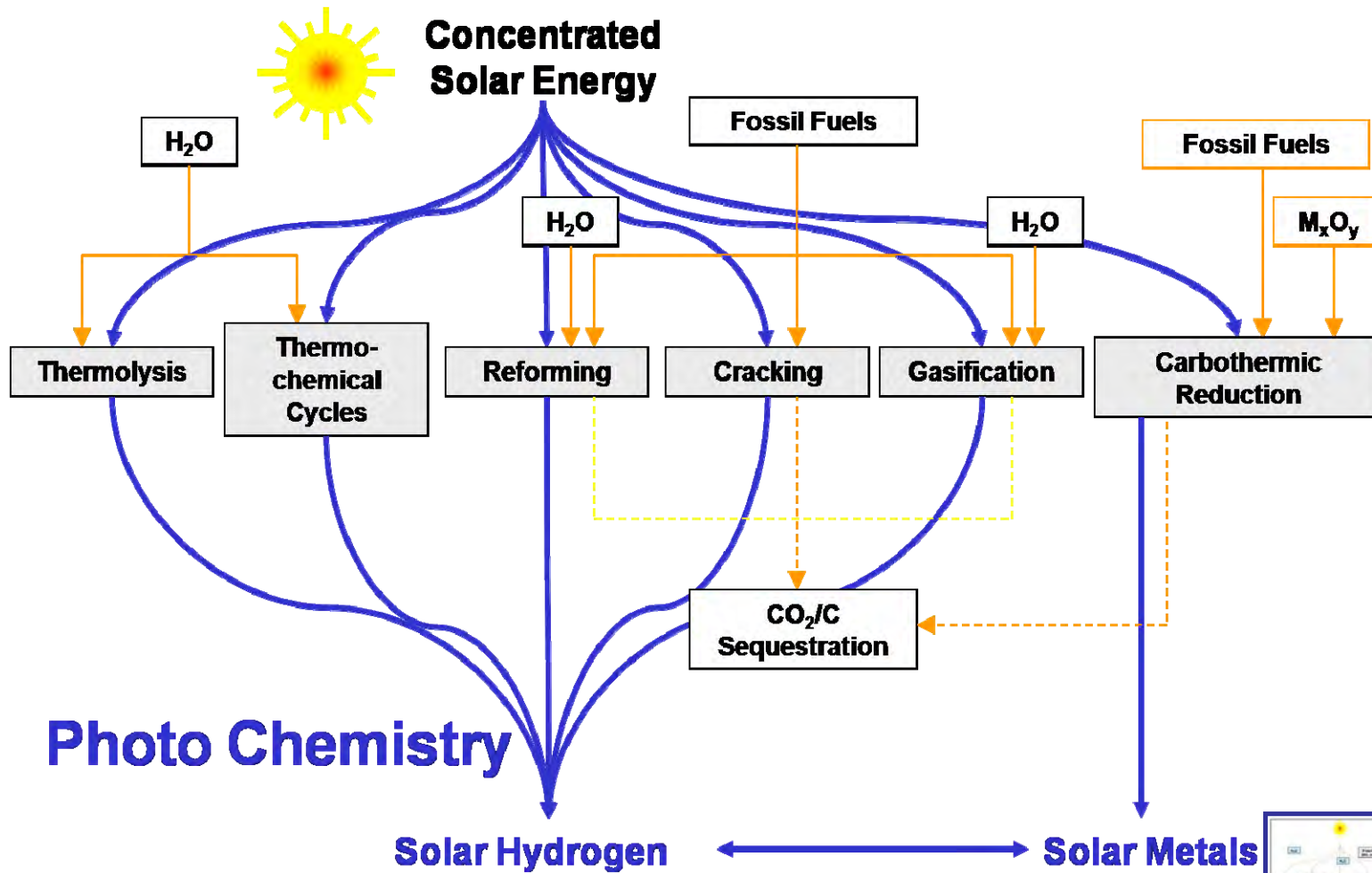


Distributed Generation System:
3 kW system
120/240 Volts AC
Autonomous operation

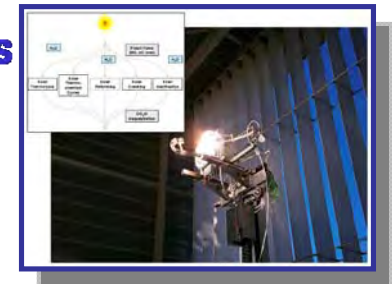


SolarPACES

Solar Chemistry



SolarPACES



SP Vision and Mission

We developed Vision and Mission Statements, and a Strategic Objective to guide our activities.

IEA SolarPACES VISION

Our vision is that concentrating solar technologies contribute significantly to the delivery of clean, sustainable energy worldwide.

IEA SolarPACES MISSION

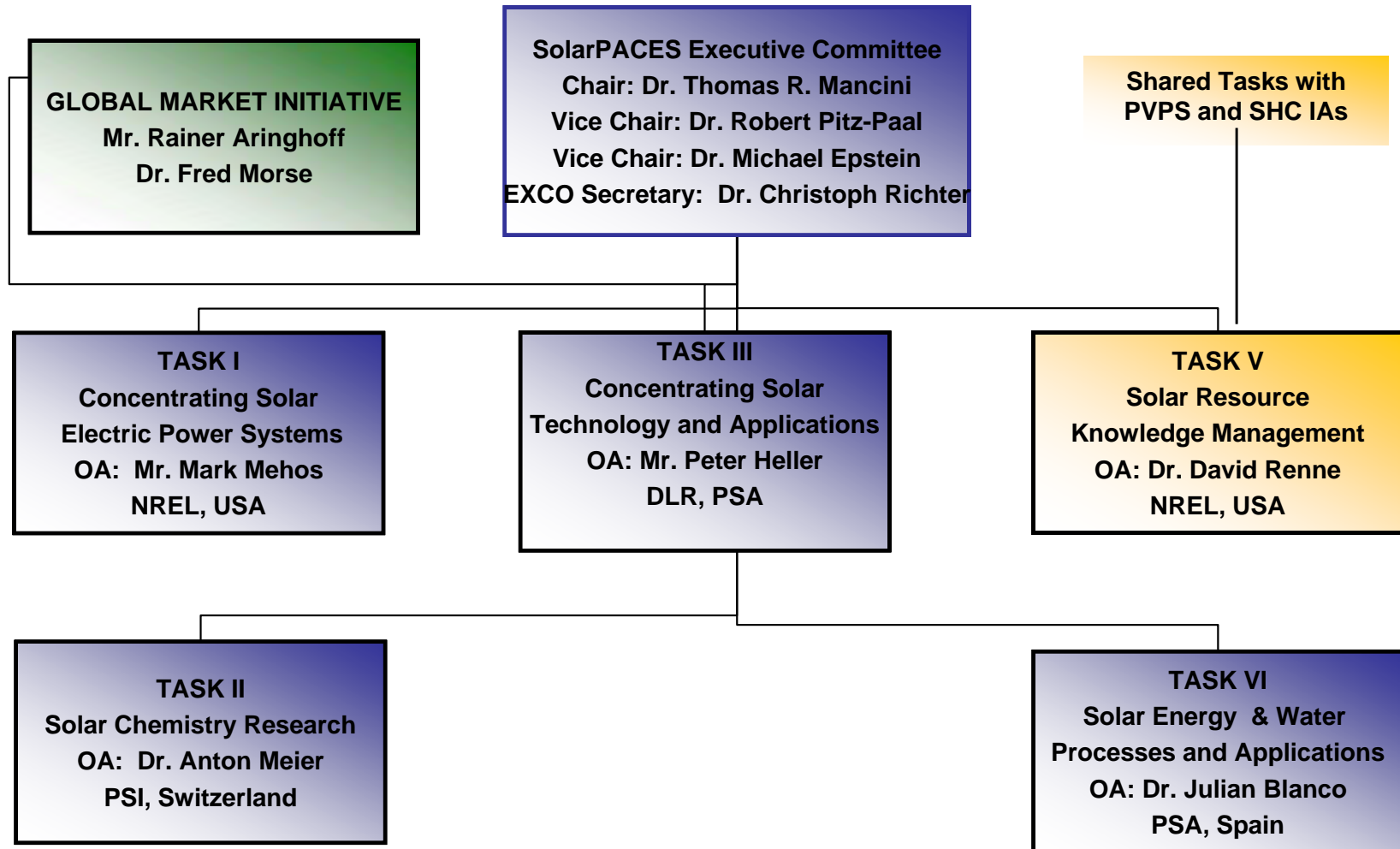
Our mission is to facilitate technology development, market deployment and energy partnerships for sustainable, reliable, efficient and cost-competitive concentrating solar technologies by providing leadership as the international network of independent experts.



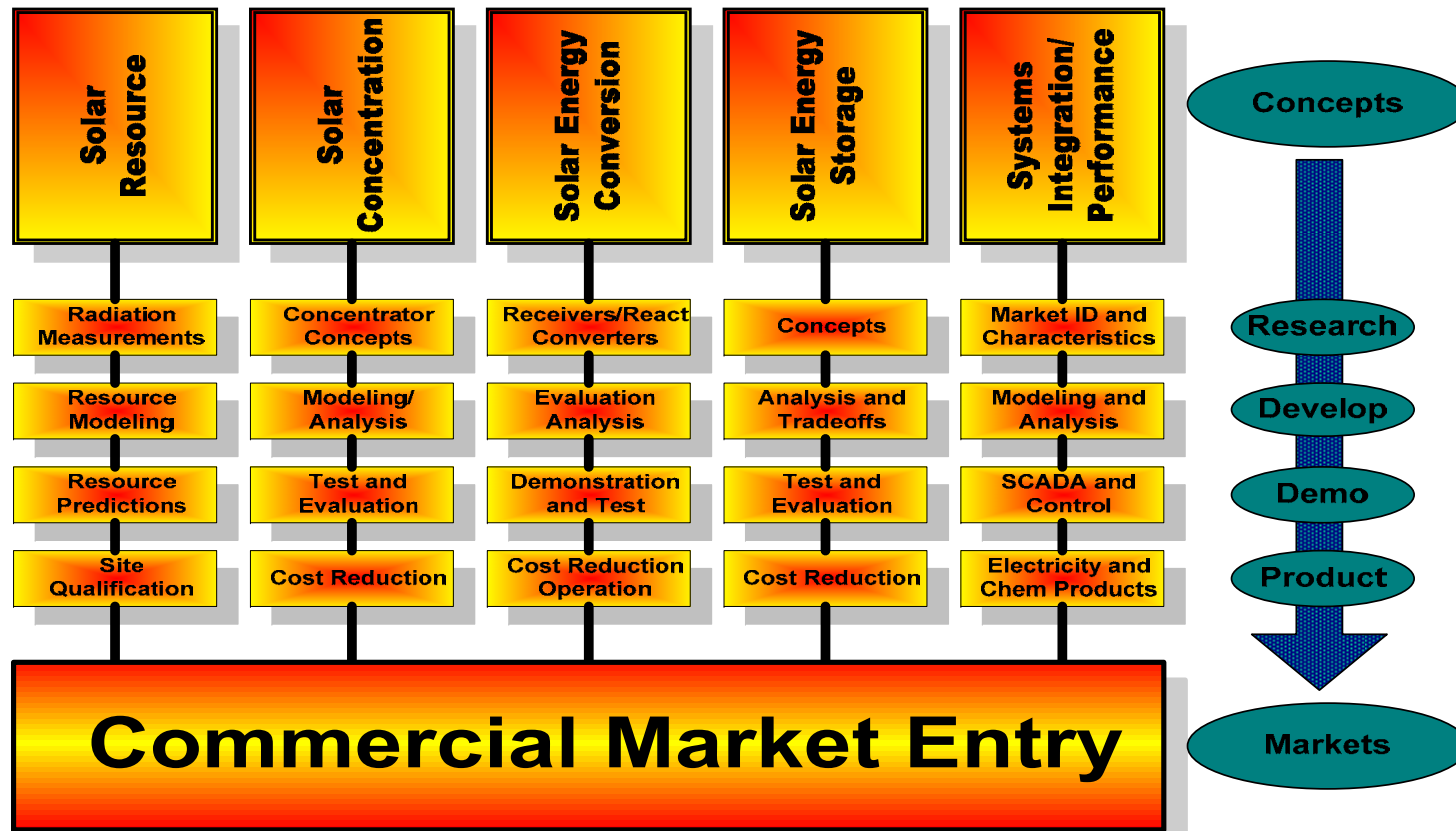
Organization of SolarPACES



SolarPACES



SolarPACES Activity Matrix



We are working to determine how SolarPACES can best support the CSP industry, utilities, financial institutions, regulators, and governments in the emerging CSP marketplace.



SolarPACES

Issues Facing SolarPACES

- **Determining how best to support industry as they move quickly to deploy systems**
- **Defining and supporting working collaborations with industry and the R&D groups in various countries.**
- **Respecting and protecting Intellectual Property.**
- **Redefining collaboration among R&D working groups within SolarPACES.**
- **Addressing the shortage of engineers to staff the CSP industry and the R&D communities in the various countries.**



SolarPACES

CSP Test Facilities Worldwide (SolarPACES members)

Solar PACES



SolarPACES



CNRS (F)



DLR (D)



PSI (CH)



Sandia, NREL (US)



ENEA (I)



PSA (E)



WIS (IL)



KIER (KOR)



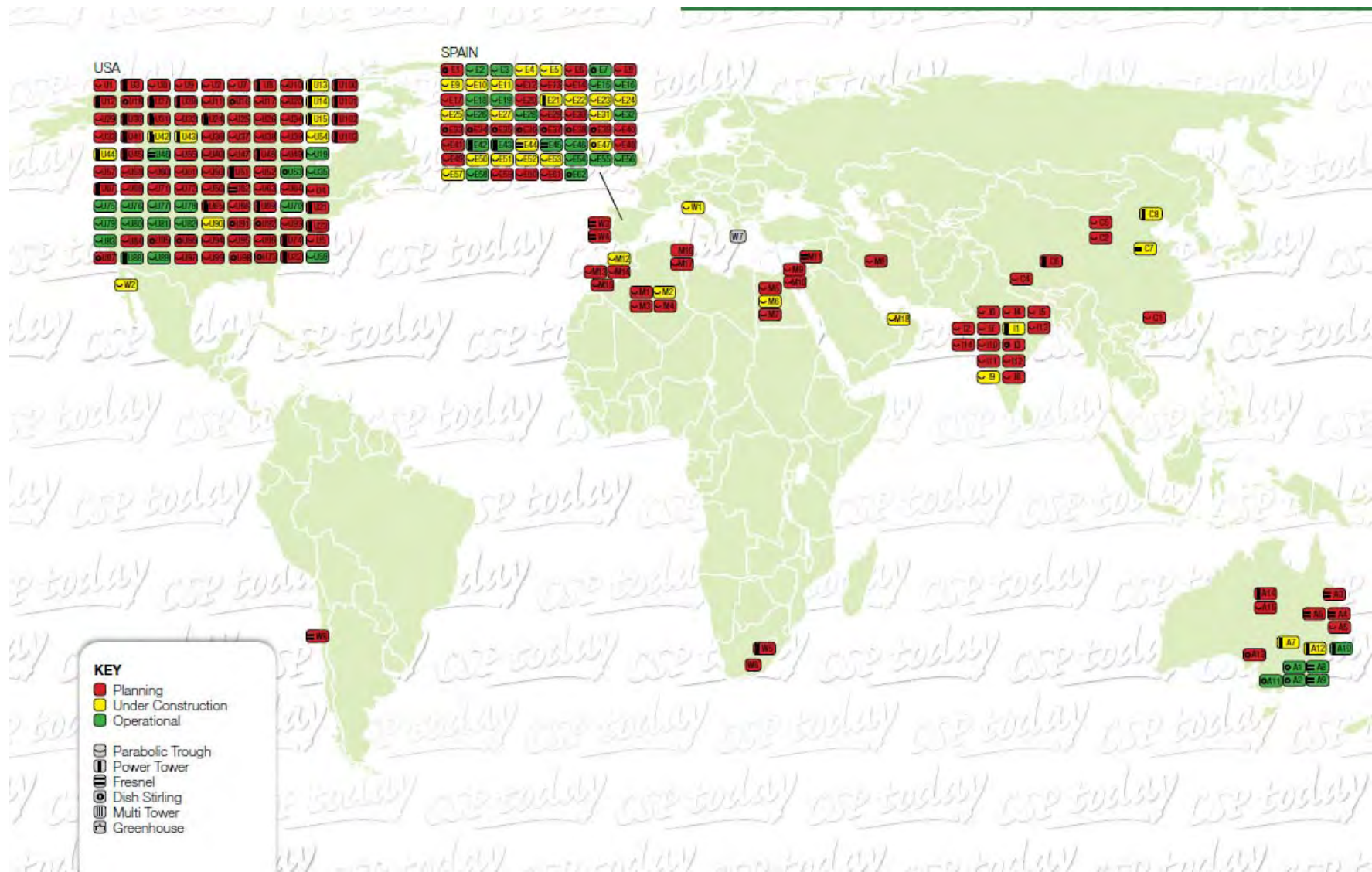
CSIRO (AUS)



CSP development Worldwide



SolarPACES



Worldwide Operating Systems



SolarPACES

YEAR	COMPANY	PLANT NAME	UTILITY/LOCATION		MW
1985	Luz	Solar Energy Generating Systems (SEGS) I	SCE Daggett, CA	Trough	14
1986	Luz	Solar Energy Generating Systems (SEGS) II	SCE Daggett, CA	Trough	30
1987	Luz	Solar Energy Generating Systems (SEGS) III	SCE Kramer Junction, CA	Trough	30
1987	Luz	Solar Energy Generating Systems (SEGS) IV	SCE Kramer Junction, CA	Trough	30
1988	Luz	Solar Energy Generating Systems (SEGS) V	SCE Kramer Junction, CA	Trough	30
1988	Luz	Solar Energy Generating Systems (SEGS) VI	SCE Kramer Junction, CA	Trough	30
1989	Luz	Solar Energy Generating Systems (SEGS) VII	SCE Kramer Junction, CA	Trough	30
1990	Luz	Solar Energy Generating Systems (SEGS) VIII	SCE Harper Lakes, CA	Trough	80
1990	Luz	Solar Energy Generating Systems (SEGS) IX	SCE Harper Lakes, CA	Trough	80
2005	Solargenix	Saguaro Solar Power Plant	APS Red Rock, AZ	Trough	1
2007	Acciona	Nevada Solar One	NV Energy, Boulder City Nv	Trough	64
2008	ACS Cobra	Andasol 1	Granada, SP	Trough	50
2009	ACS Cobra	Andasol 2	Granada, SP	Trough	50
2009	Acciona	Alarado 1	Badajoz, SP	Trough	50
2009	Sopogy	Holaniku	HELCO at Keahoe Point Kona, Hawaii	Trough	2
2009	Iberdrola	Puertollano	Puertollano, Ciudad Real, SP	Trough	50
2010	Abengoa	Solnova 1	Sanlucar de Mayor, SP	Trough	50
TOTAL INSTALLED MW					671
YEAR	COMPANY	PLANT NAME	UTILITY/LOCATION		MW
2007	Abengoa	PS 10	Sanlucar de Mayor, Sp	Tower	11
2008	Brightsource	SEDC	Negev, Israel	Tower	5 th
2009	Abengoa	PS 20	Sanlucar de Mayor, Sp	Tower	20
2009	eSolar	Sierra SunTower	SCE Antelope Valley, CA	Tower	5
TOTAL INSTALLED MW					39
YEAR	COMPANY	PLANT NAME	UTILITY/LOCATION		MW
2010	Stirling ES	Maricopa Solar	Phoenix, AZ	Dish	1.5
TOTAL INSTALLED MW					1.5

~ 1 GW of trough systems in operation.

More than 5 GW of projects under signed PPA worldwide.



Additional Back Up Slides



SolarPACES

TASK I PLAN: CSP SYSTEMS

Support deployment of CSP systems

Cooperate with industry, utilities, gov. agencies to

- **Monitor the progress of commercial CSP projects**
- **Define the generic characteristics of CSP grid integration**
- **Develop methodologies for “Green Label” certification, etc.**
- **Exchange experience and lessons learned**
- **Monitor System Performance**
- **Develop Guidelines for Independent Performance Certification**
- **Build Manufacturing and Operational Capacity**
- **Perform outreach and disseminate information**



SolarPACES

TASK II PLAN: SOLAR CHEMISTRY

Demonstrations at industrial scale the production of fuels and chemicals.

- Identify the most promising thermochemical cycles for hydrogen production and down-select
- Develop lower cost receiver/tc reactor technology
- Test a 100 kW-scale demo for the solar reduction of ZnO
- Demo 400 kW synthesis gas production from solar reforming
- Develop a 500 kW solar reactor for the industrial production of hydrogen by steam-gasification
- Intensify collaboration on hydrogen research with IEA-HIA and IPHE (Task 25)



SolarPACES

TASK III: CSP TECHNOLOGIES

Support deployment through development of needed components and tools.

- **Develop Guidelines for component performance measurements**
- **Prioritize R&D activities with high impact on cost reduction**
- **Evaluate Reliability of solar components and systems**
- **Develop Tools and methods for quality assurance of components and systems**
- **Compare and evaluate alternative storage concepts**
- **Perform Power plant optimization studies for arid regions**



SolarPACES

Task V Plan: Solar Resource Mgmt.

Facilitate the application of solar energy techniques by providing better information on solar resources Worldwide.

- Standardize solar resource products to insure worldwide comparability and acceptance
- Develop a common structure for archiving, processing and accessing solar resource information.
- Improve techniques for solar resource characterization
- Develop methods to provide solar radiation forecasts



SolarPACES

Global Market Initiative

Facilitate project development

- **Identify and promote needed policies and regulations that would facilitate the building of CSP plants in GMI countries with emphasis on countries in Region I and Region II.**
- **Identify and promote supportive financing mechanisms, i.e., investment and production tax credits, and bankable Clean Development Mechanisms and Joint Implementation Actions.**
- **Provide a forum for exchange of lessons learned among CSP project developers and key stakeholders.**



SolarPACES

Election of New SolarPACES Chairman

- We ask for candidates to present themselves and their program in the September meeting in Granada
- Election takes place directly after in the meeting



SolarPACES

Do we want to change our governance model to involve more members?

Possible models

- **Elect chairman and one vice chairmen in parallel (in September)**
- **Replace chairman by vice chairman after 2 years (or if chairman resigns) and elect new vice chairman.**
- **Continue so every two years**



Chairman candidate should have targets

- **New members**
- **Activities of secretariat**
- **Cooperation with IEA**
- **Cooperation with other parties**
- **Management of Initiatives of strategic plan**



SolarPACES