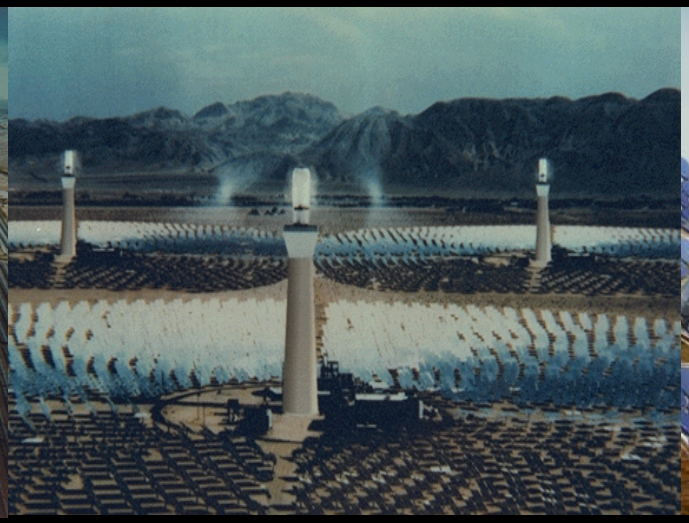
From Research to CSP Market Introduction

World Wide Progress and Advances of Trough Projects

Dr. Michael Geyer

Executive Secretary of the IEA SolarPACES Implementing Agreement

TROUGH WORKSHOP DENVER MARCH 8, 2007


Five Years Ago CSP and SolarPACES were almost Declared Dead

Today CSP makes Headlines on National Newspaper Cover Pages

SPAIN: 3x 50MW AndaSol

- 510.120m² Solar Field and 7.5hours Storage
- 176 GWh annual production, 12% gas
- EPC Cost 260Mio Euro first Plant
- 5Mio EU Grant for AndaSol-1
- Financial Closure 31.5.2006, NTP 1.7.2006
- 1st STARTUP SCHEDULED 1.7. 2008

First SKALET Collectors assembled at Andasol-1


SolarPACES
Concentrating Solar Power (CSP) R&D&D started 2000 years ago under a Defense Program …

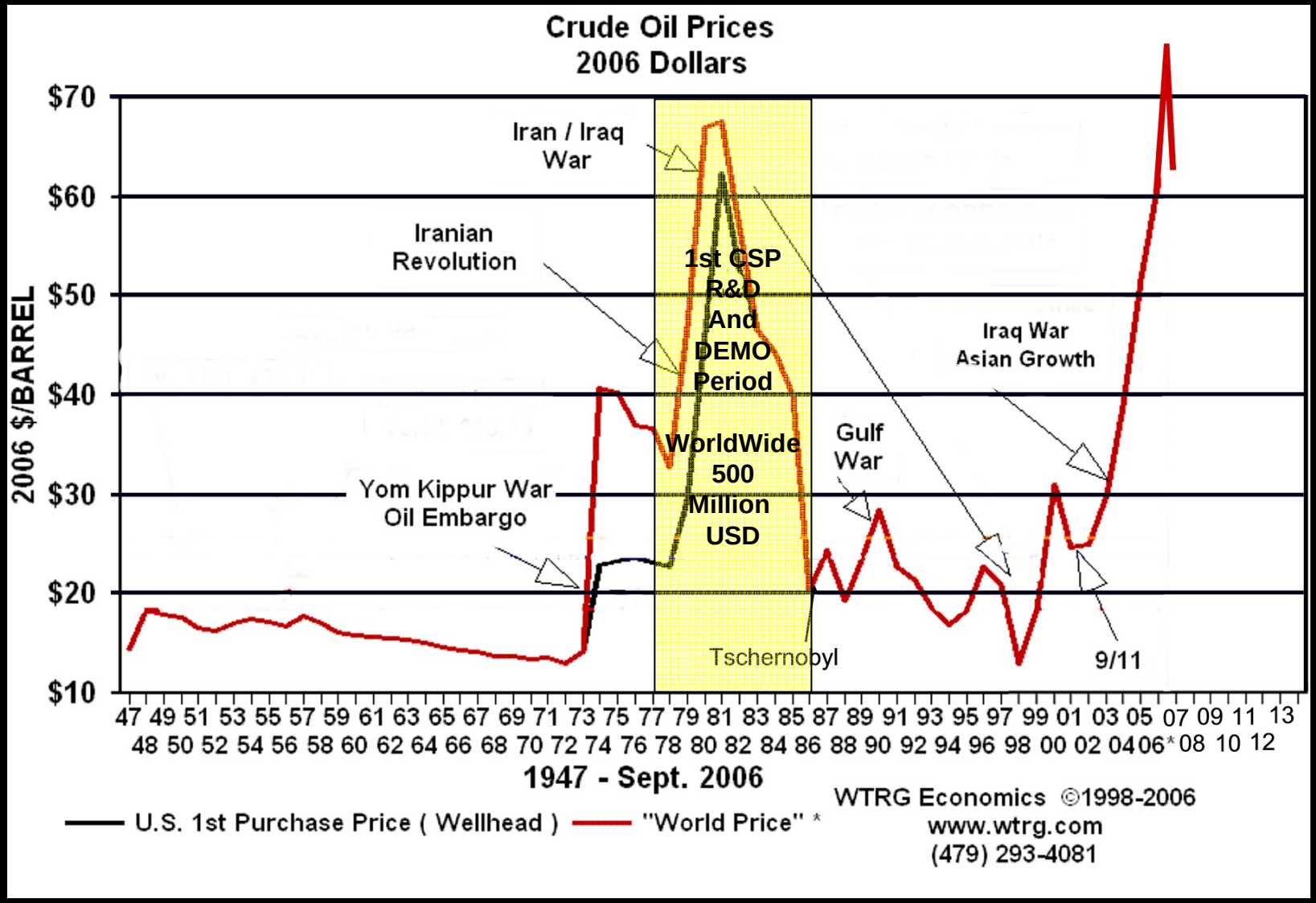
1912 first parabolic trough collector by Shuman in Cairo
62m length x 4m aperture

100 years ago the first parabolic trough produced direct solar steam near Cairo, when coal was shipped from England to Egypt

1918 the curtain
fall over the further collector development


Until the first Oil Crisis in the late 70s
gives rebirth to CSP Research

The Pork Cycles of R&D and Plant Construction in CSP



Solar Thermal Power Facilities Worldwide



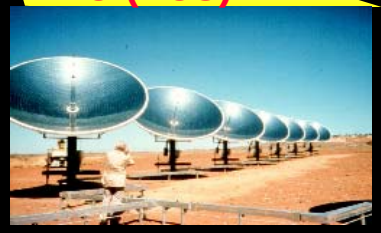

PSA (E)


PSI (CH)


Solar One (US)

CNRS (F)


WIS (IL)

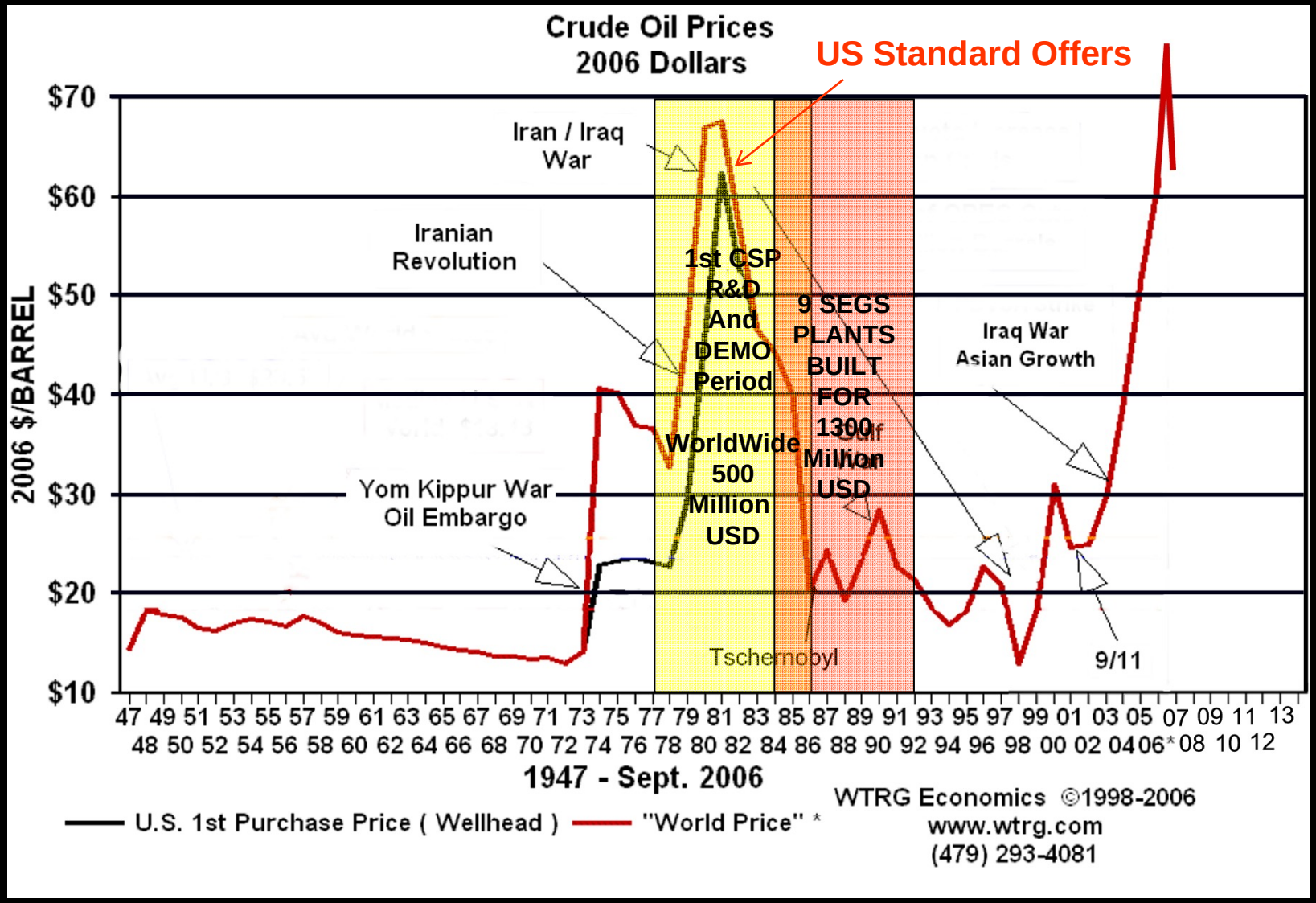

ANU (AUS)


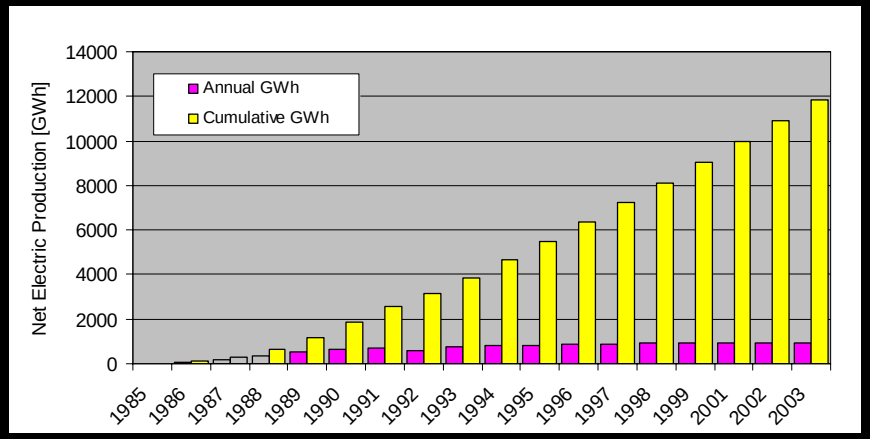
CRTF Sandia (US)


SolarPACES

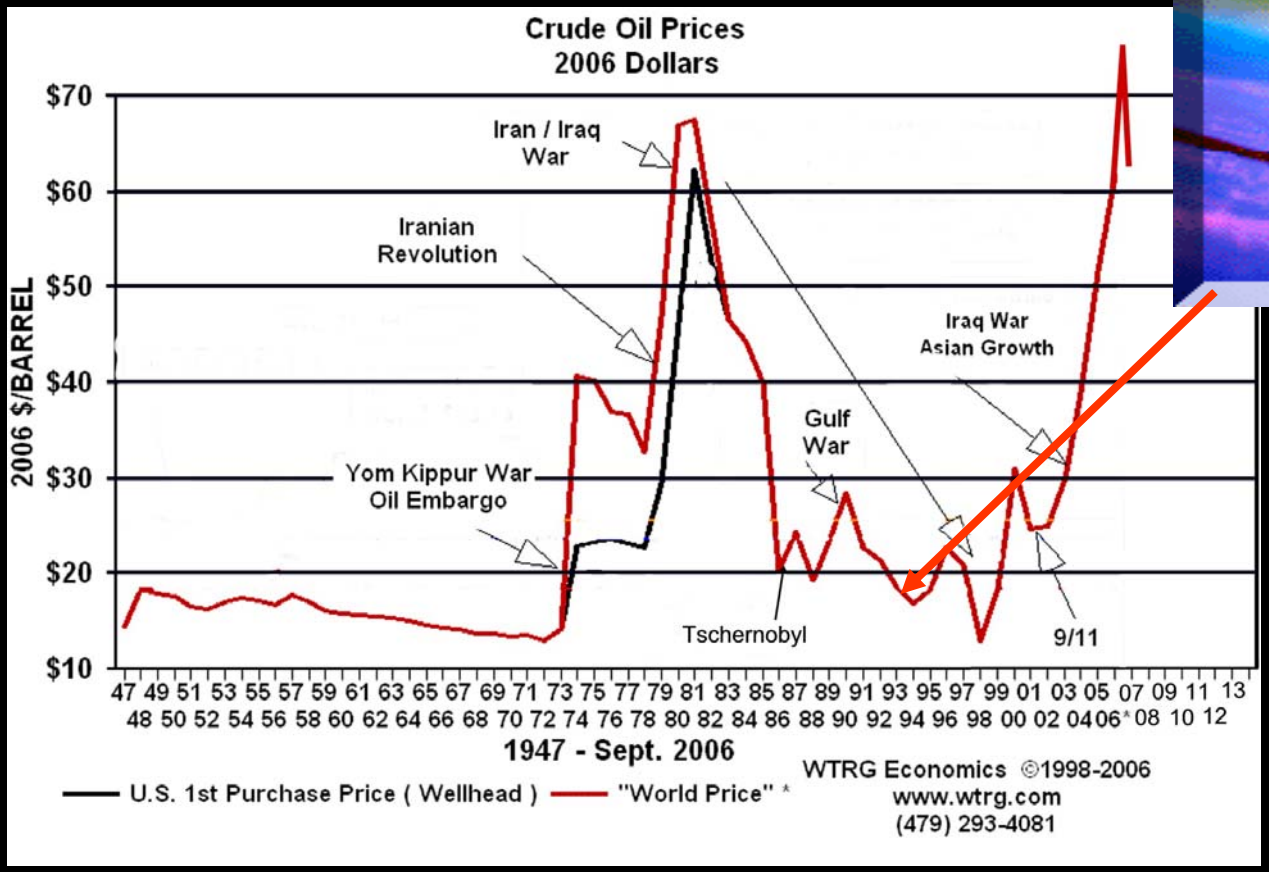
ACUREX Troughs for Process Heat and Power

First Worldwide Market Opportunity: US Standard Offers No.4



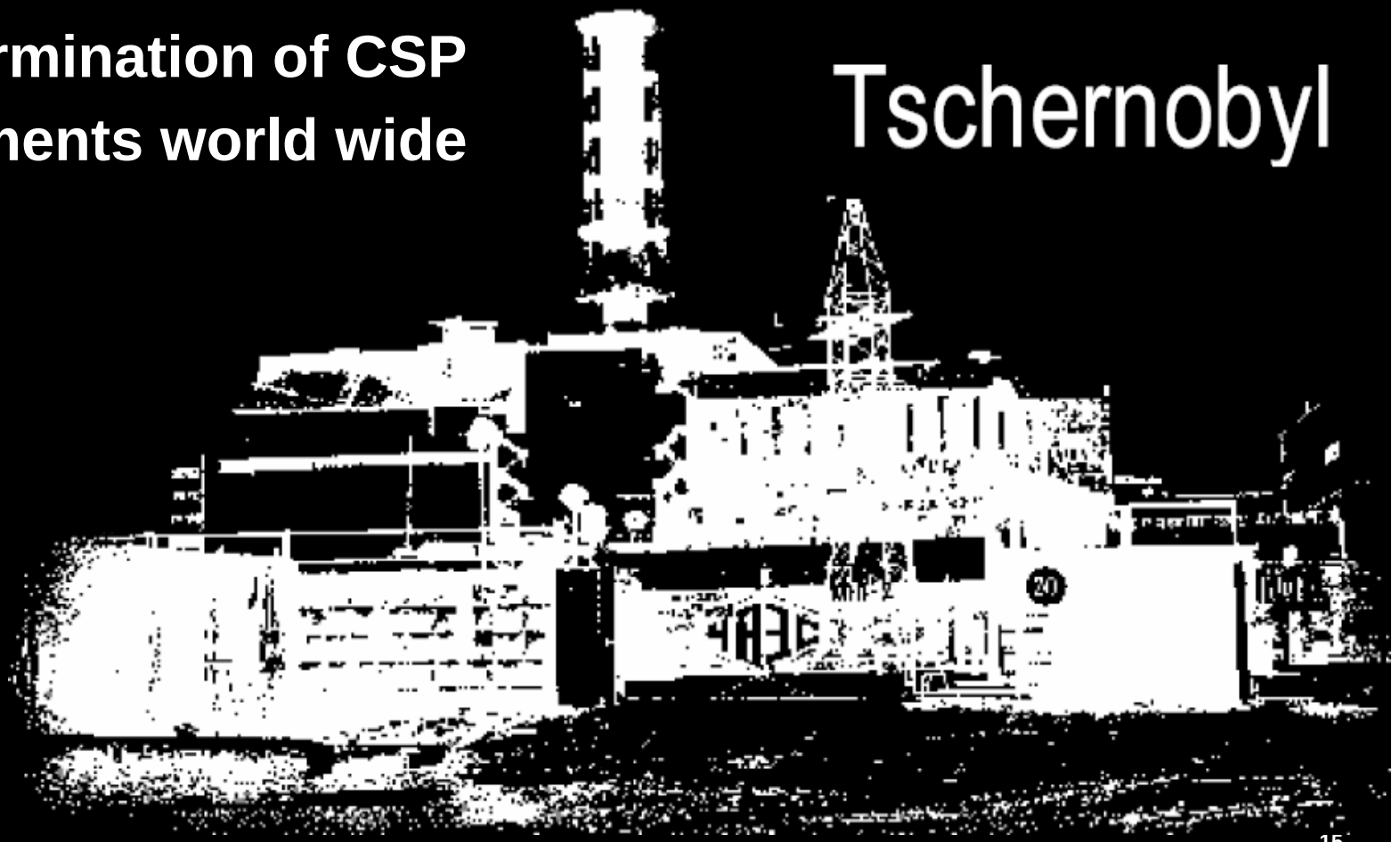


In this first market window, 354MW of 600MW PPA are built

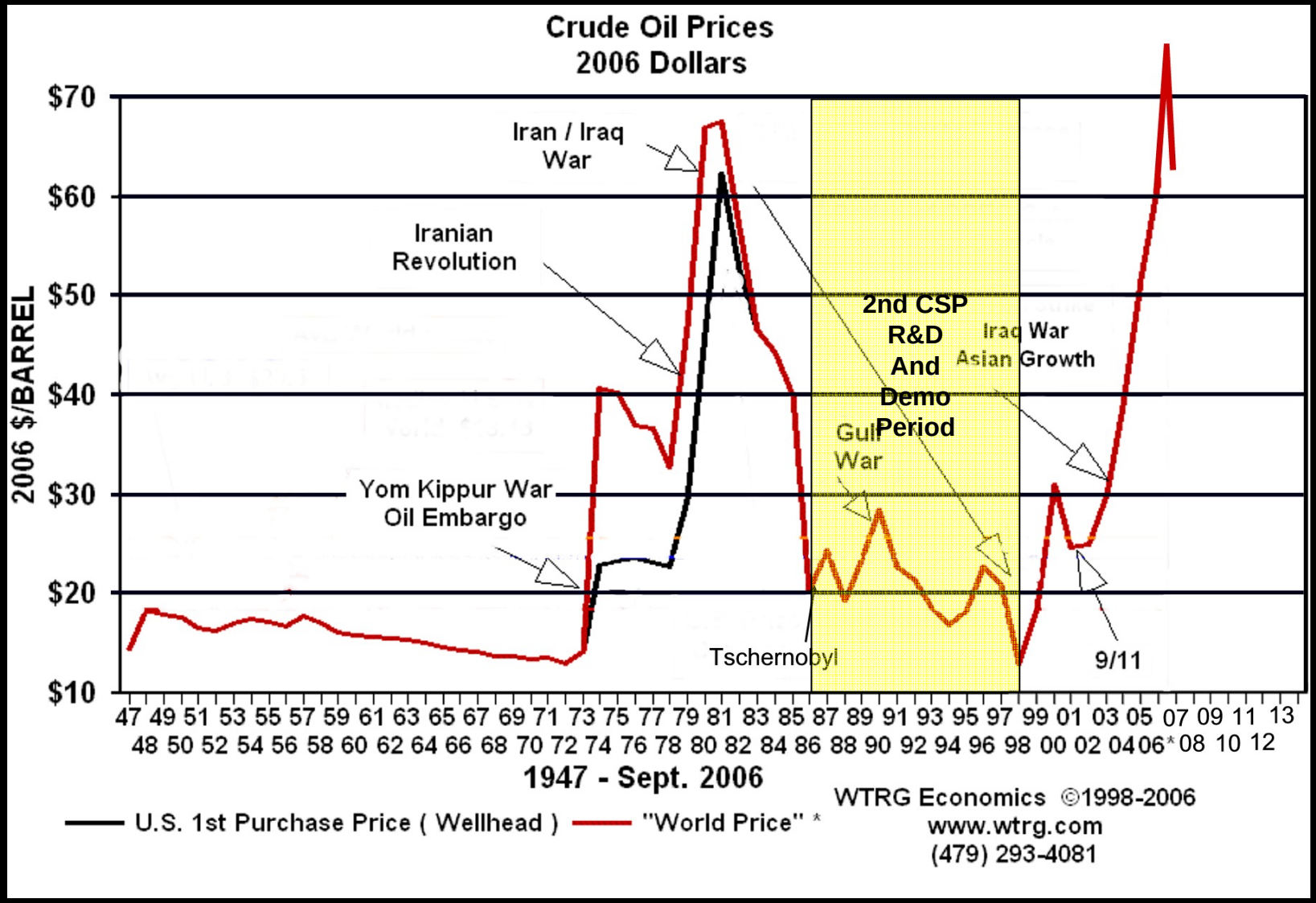


Demise of Luz after Fall of Energy Prices in 1991/92

With Oil & Gas at it‘s minimum, the 90s would have been the termination of CSP developments world wide



1986: Tschernobyl saves CSP R&D Budgets in Europe



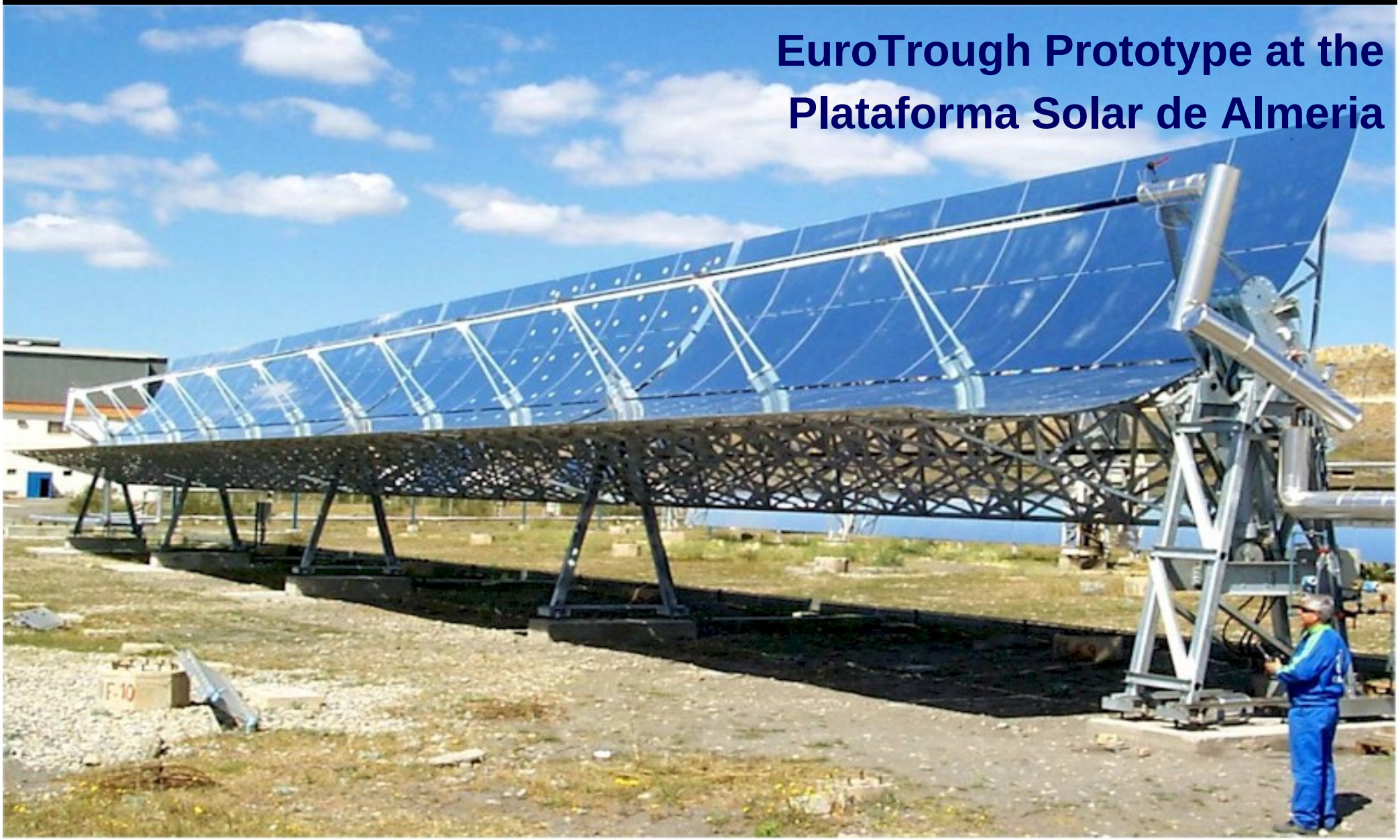
SolarPACES

1996-2000 DISS Direct Solar Steam from Troughs at the Plataforma Solar de Almeria

Ciemat

SolarPACES

EuroTrough Prototype at the Plataforma Solar de Almeria



SolarPACES

4500m² SKAL-ET Testloop at Kramer Junction

SolarPACES

1 MW ORC plant at Saguaro Power Plant south of Phoenix, AZ. Solargenix, APS

SOLARGENIX ENERGY
THE NATURAL POWER FOR GOOD
an acciona company

Archimide

Grande Progetto Solare Termodinamico

molten salts
parabolic trough
ISCC power plants

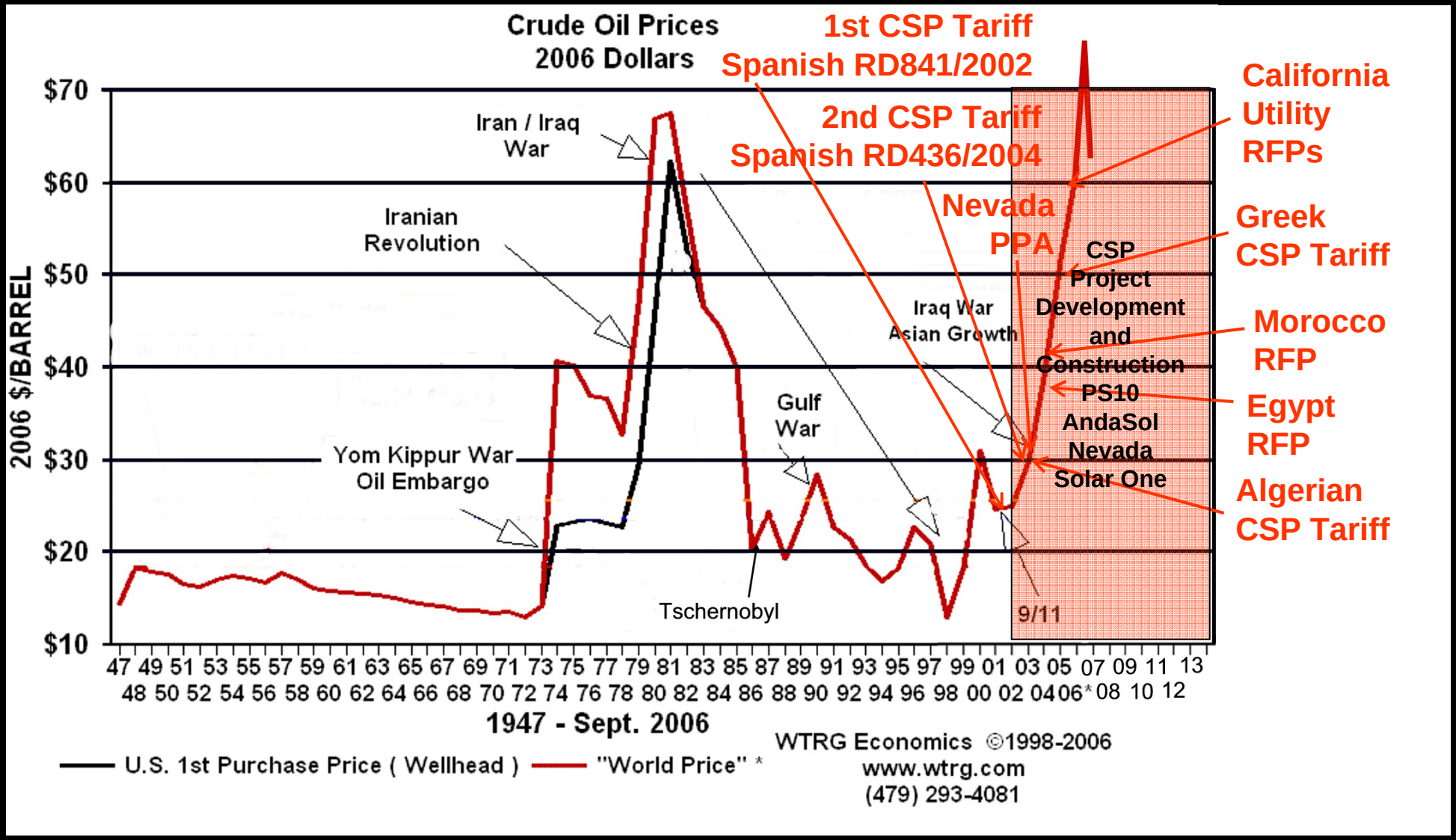
ENEA

ENEA proved feasibility of 550°C/290°C Molten Salt Trough

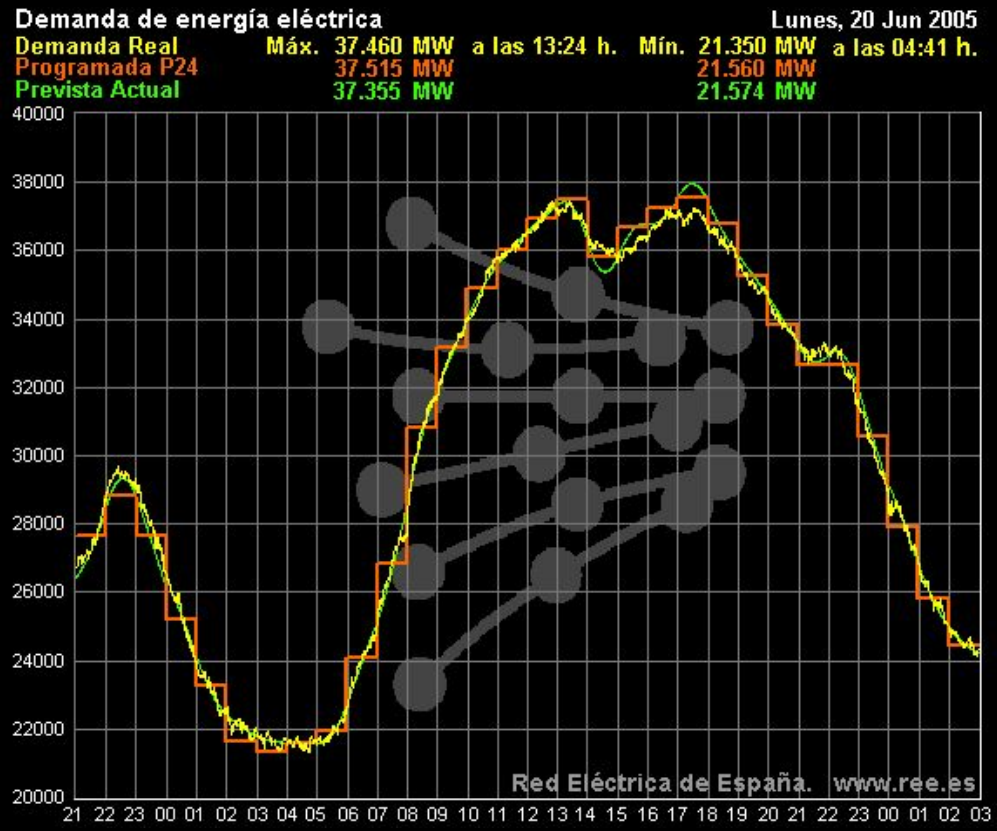
Fresnel Collectors

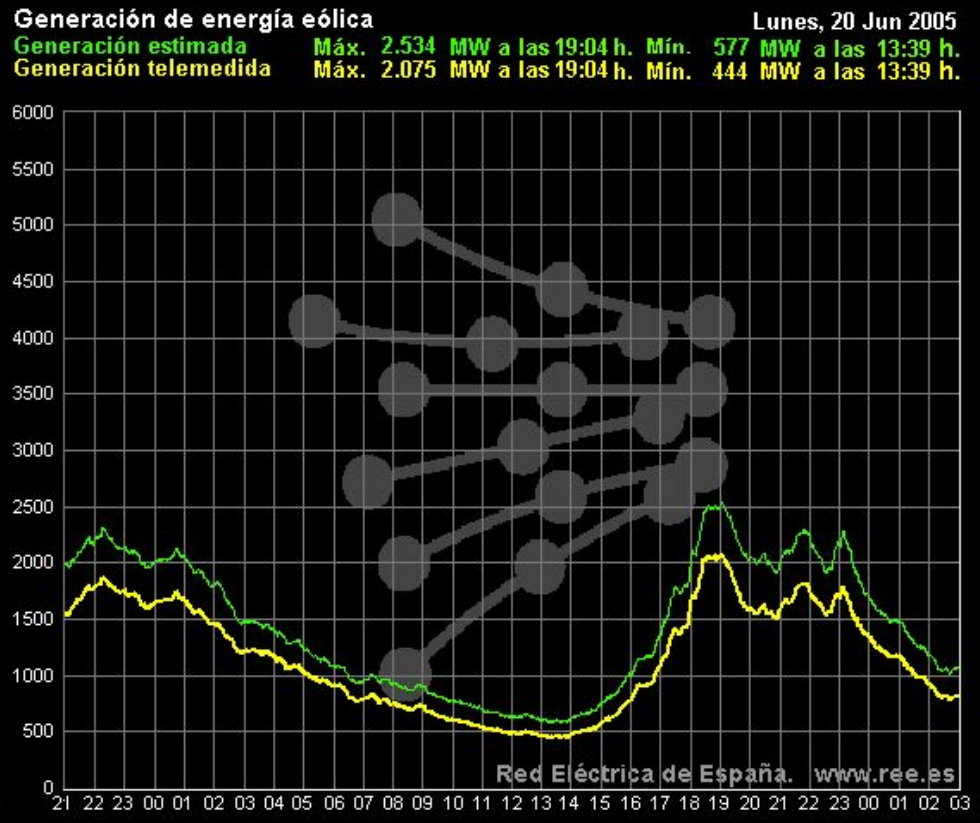
John Marcheff Solar Project at Lidell Coal Power Station, Australia

Second Market Chance for CSP



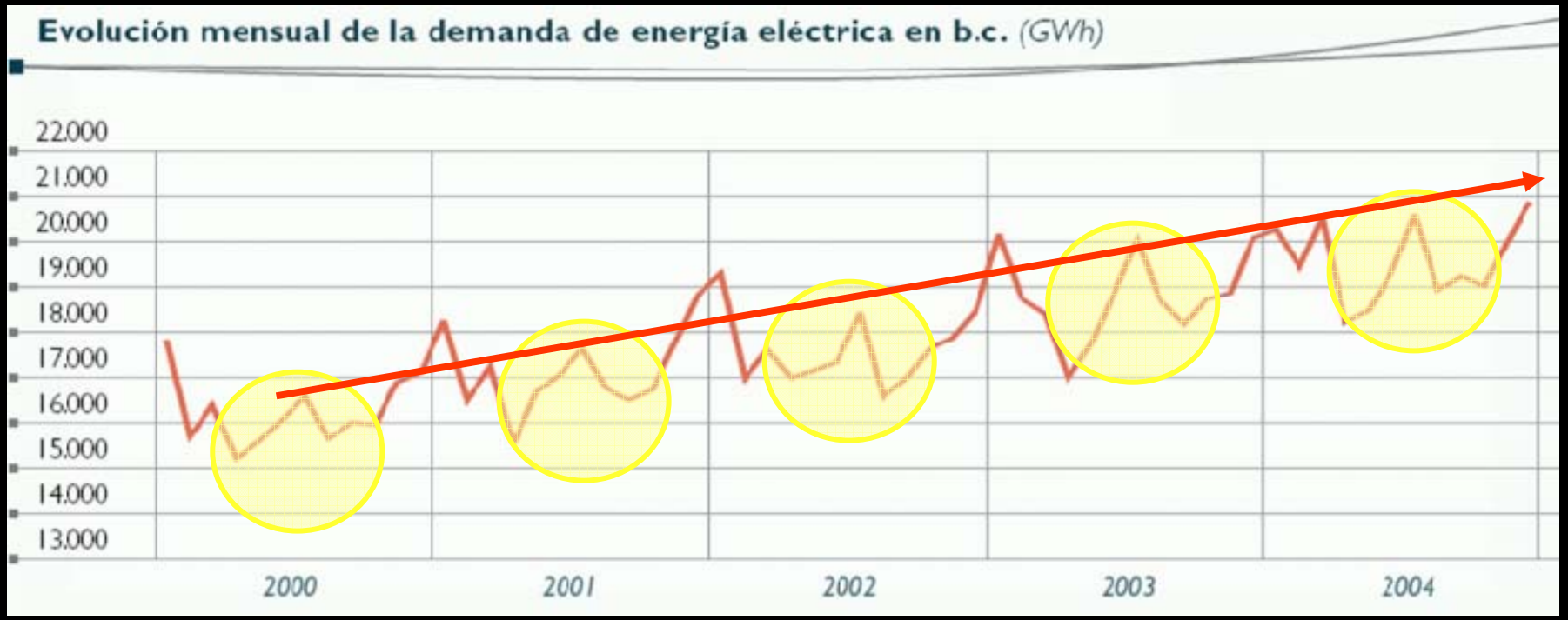
Record Summer Peak in Spain 2005





- Solar thermal can supply firm and dispatchable peak power in summerly heat periods when hydro and wind are scarce

Growth of Spanish Peak Demand 2000-2004



New Spanish Feed-In Law for CSP: Real Decreto 436/2004

MINISTERIO DE ECONOMÍA

5562 *REAL DECRETO 436/2004, de 12 de marzo, por el que se establece la metodología para la actualización y sistematización del régimen jurídico y económico de la actividad de producción de energía eléctrica en régimen especial.*

2. Resto de instalaciones de energía fotovoltaica del subgrupo b.1.1:

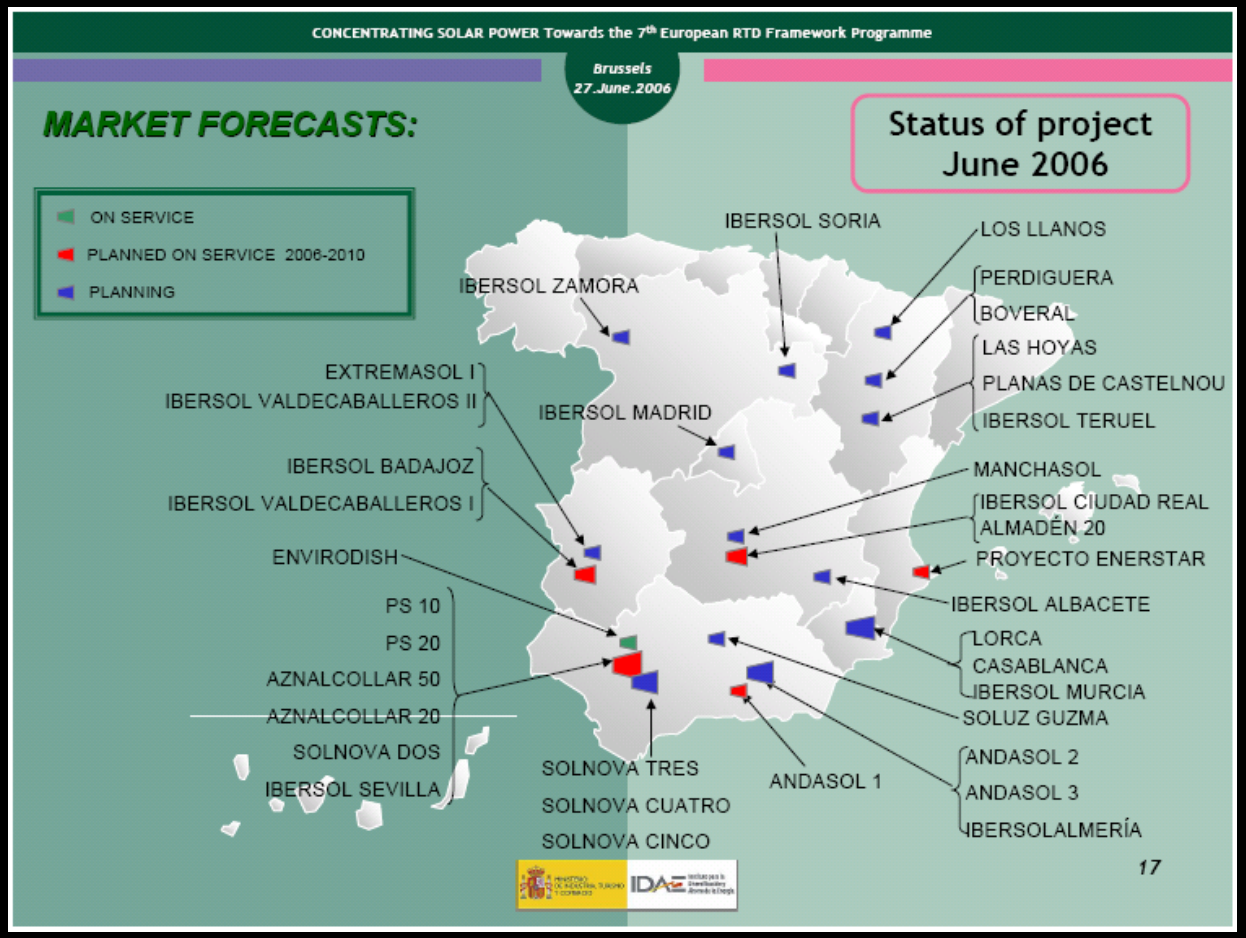
Tarifa: 300 por ciento durante los primeros 25 años desde su puesta en marcha y 240 por ciento a partir de entonces.
Prima: 250 por ciento durante los primeros 25 años desde su puesta en marcha y 200 por ciento a partir de entonces.
Incentivo: 10 por ciento.

3. Instalaciones de energía solar térmica del subgrupo b.1.2:

Tarifa: 300 por ciento durante los primeros 25 años desde su puesta en marcha y 240 por ciento a partir de entonces.
Prima: 250 por ciento durante los primeros 25 años desde su puesta en marcha y 200 por ciento a partir de entonces.
Incentivo: 10 por ciento.

- Grants same tariffs for PV and CSP from 100kW to 50MW
- Cost covering with up to 0.21Euro/kWh
- Bankable with 25 year guarantee
- Annual adaptation to electricity price escalation
- 12-15% natural gas backup allowed to grant dispatchability and firm capacity
- After implementation of first 200MW tariff will be revised for subsequent plants to achieve cost reduction

Spanish CSP Feed-In Law Boosts CSP Projects



- Within 3 months after publication of RD436, half a dozen new CSP projects started development
- The new contractors are willing to take the risk of full EPC guarantees
- High interest of investors from utility sector to participate in equity
- Competition of commercial banks for financing
- New players ready to offer in GEF projects, since now they see a home market

International CSP Project Developments

SolarPACES first IA joined by Algeria

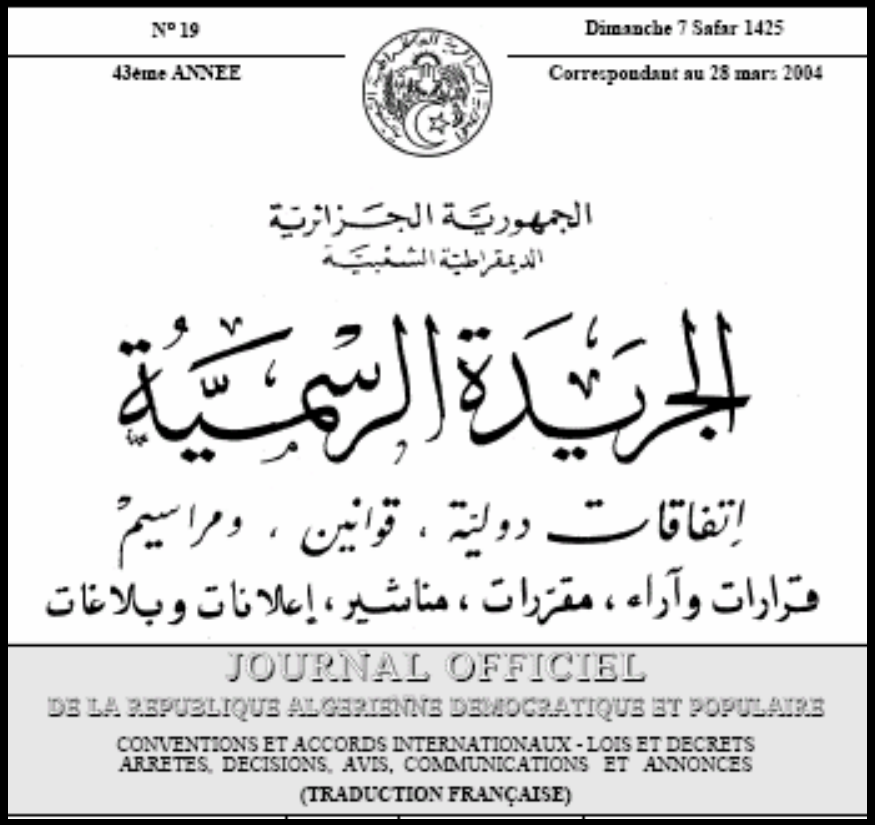
New Energy Algeria (NEAL) was mandated by the Algerian Government to become signator to the IEA SolarPACES Implementing Agreement on 13 January 2003 at the IEA HQ in Paris.

From left to right: Richard Sellers (IEA Head Renewable Energy Unit), Hanns-Joachim Neef (IEA Head Energy Technology Collaboration Division), Michael Geyer (IEA-SolarPACES Executive Secretary), William C.Ramsey (IEA Executive Director), M. Chakib Khelil (Algerian Minister for Energy and Mines), Tewfik Hasni, (President Director General of New Energy Algeria NEAL)

Combine Solar and Gas for Power Export

Algerian Feed In Law 28-3-04

Renewable Energy Target
5% of Electricity Production by 2010



N° 19 — Dimanche 7 Safar 1425

43ème ANNEE — Correspondant au 28 mars 2004

الجمهورية الجزائرية
الديمقراطية الشعبية

الجريدة الرسمية

اتفاقات دولية ، قوانين ، ومراسيم
قرارات وآراء ، مقررات ، مناشير ، إعلانات وبلاغات

JOURNAL OFFICIEL

DE LA REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

CONVENTIONS ET ACCORDS INTERNATIONAUX - LOIS ET DECRETS
ARRETES, DECISIONS, AVIS, COMMUNICATIONS ET ANNONCES

(TRADUCTION FRANÇAISE)

Art. 12. — Pour l'électricité produite à partir d'installations utilisant de l'énergie solaire thermique par des systèmes hybrides solaire-gaz, la prime s'élève à 200% du prix par KWh de l'électricité élaboré par l'opérateur du marché défini par la loi n° 02-01 du 22 Dhou El Kaada 1422 correspondant au 5 février 2002 susvisée, et ceci quand la contribution minimale d'énergie solaire représente 25% de l'ensemble des énergies primaires.

Pour les contributions de l'énergie solaire inférieure à 25%, la dite prime est servie dans les conditions ci-après :

— pour une contribution solaire 25% et plus : la prime est de 200%,

— pour une contribution solaire 20 à 25% : la prime est de 180%,

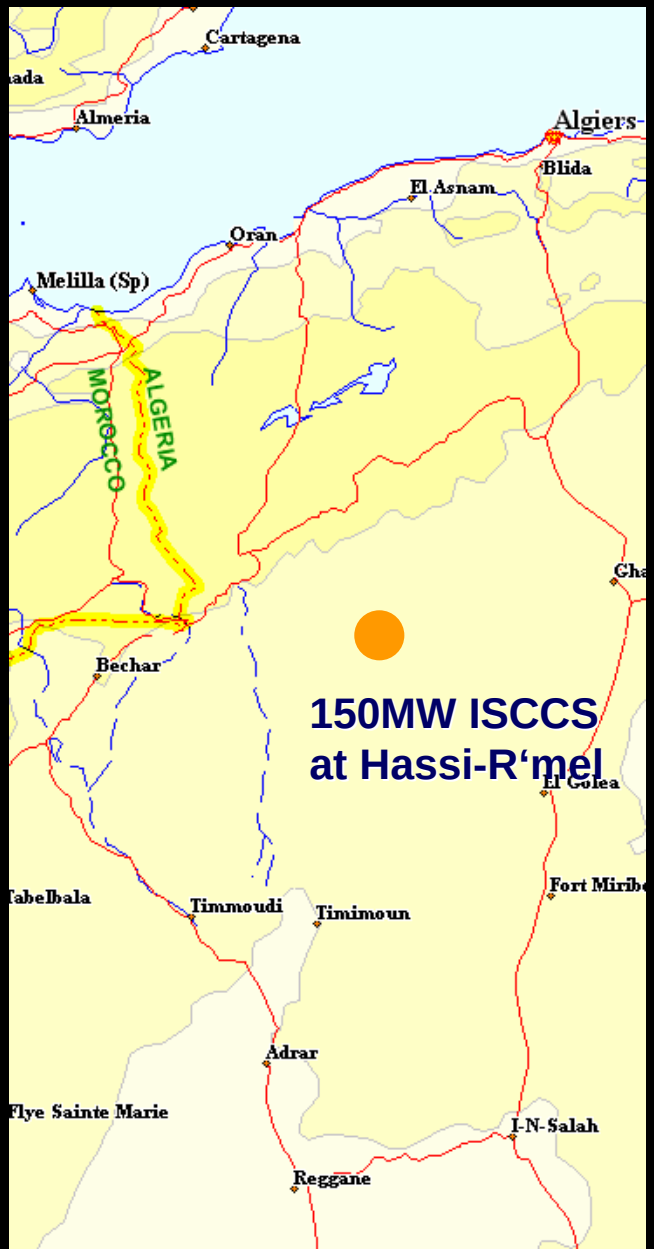
— pour une contribution solaire 15 à 20% : la prime est de 160% ,

— pour une contribution solaire 10 à 15% : la prime est de 140% ,

— pour une contribution solaire 5 à 10% : la prime est de 100% ,

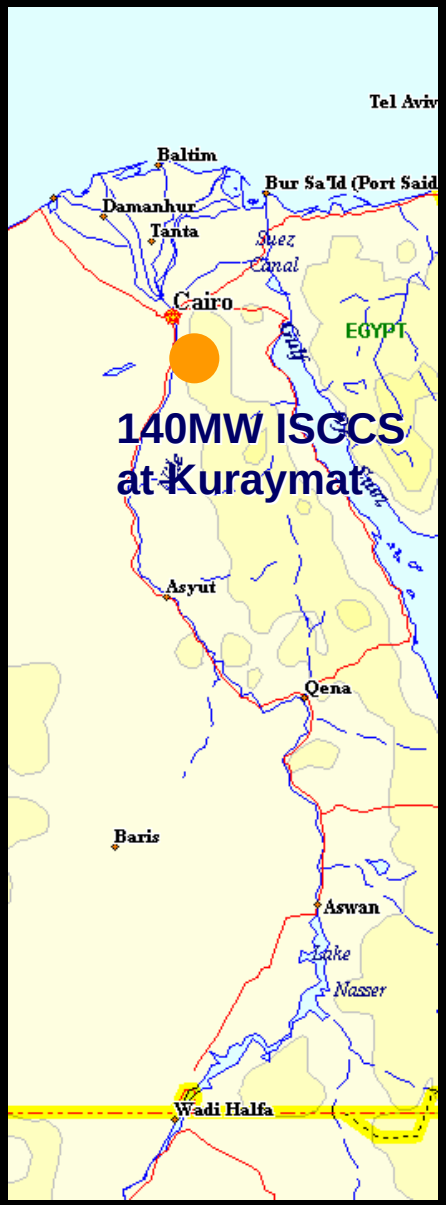
— pour une contribution solaire 0 à 5% : la prime est nulle.

ALGERIA: 150MW ISCCS with 30MW Solar



Project Site Hassi-R'mel: est. 2400kWh/m²a DNI

- Developer NEAL New Energy Algeria
- BOT project according to Algerian Feed-in Law 04-92 of March 25th 2004
- Equity 34% NEAL and 66% Bidder
- Financing mostly provided by Algerian Banks
- Abener won with an offered tariff of 4.235cents/kWh (excluding gas) and 5.3% solar

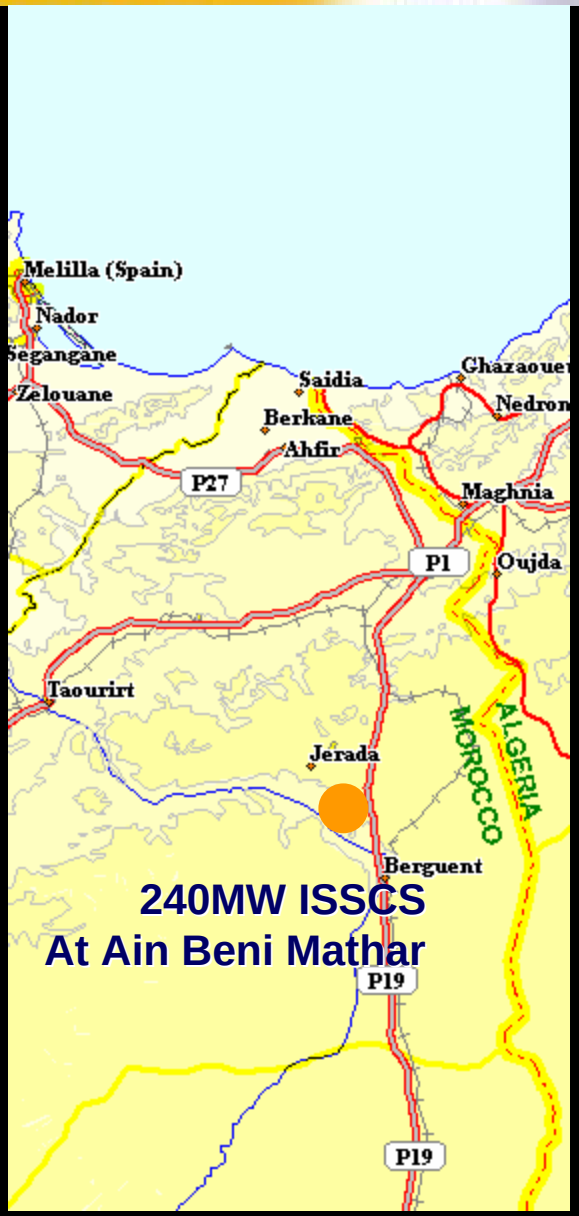


EGYPT: 146MW ISCCS with 30MW Solar Field

- Developer NREA New & Renewable Energy Agency
- EPC financed by JBIC and NREA with 50Mio Grant
- 984GWh per year, of which 64.5GWh solar
- RFP published in July 2006 with deadline 30-11-2006
- Contract award scheduled for February 2007

IRAN: 400MW ISCCS with 60MW Solar Field

- Upgrade of existing 250MW GT Plant with 366.000m² solar field and 150MW ST to 400MW ISCCS
- EPC sponsored by Iranian Power Development Company (IPDC),
- 2850GWh per year, of which 120GWh solar
- RFP now under development



MOROCCO: 228 MW ISCCS with 30MW Solar Field

- Developer ONE Office Nationale d'Electricité
- EPC financed by ADB, ONE and 50Mio GEF Grant
- 1590GWh per year, of which 56GWh solar
- RFP published on 29-08-2006 with deadline 16-01-2007
- Contract award scheduled for February 2007

Mexico: 535MW ISCCS with 30MW Solar

Sábado 23 de septiembre de 2006 | Mi cuenta | Regístrate | Centro Meteorológico

BUSCAR

CFE Comisión Federal de Electricidad

Inicio | Mapa del sitio | English

La empresa | Servicios en línea | Información al cliente | Negocios con CFE | Sala de prensa | Contáctanos

Licitaciones de CFE

Resultados de la búsqueda

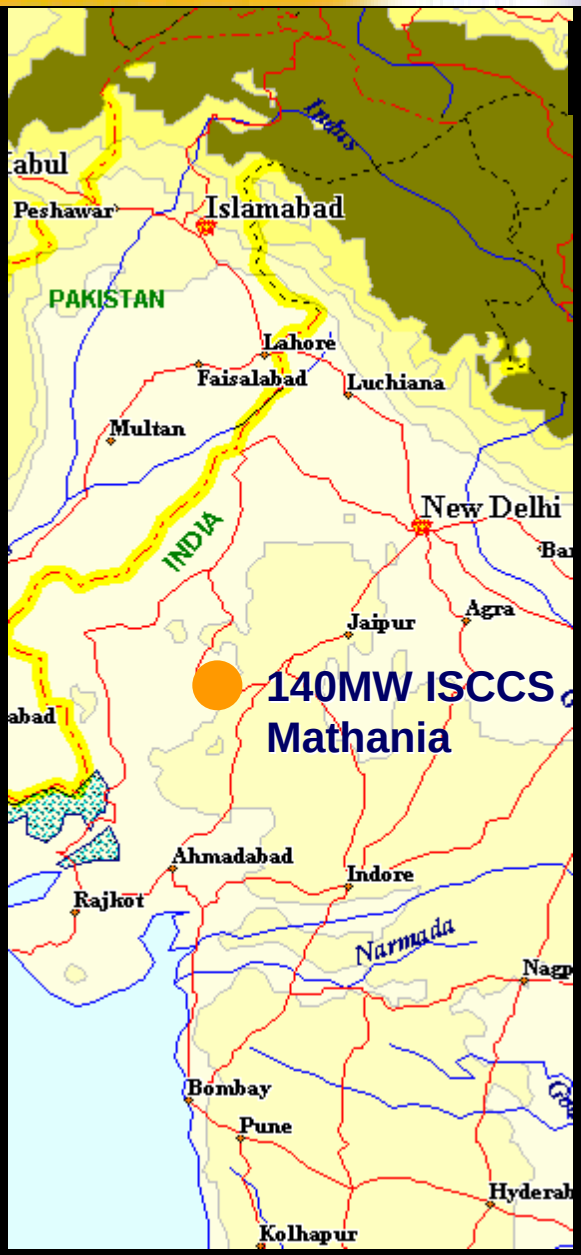
Detalle de la licitación de Obra pública

Licitación pública

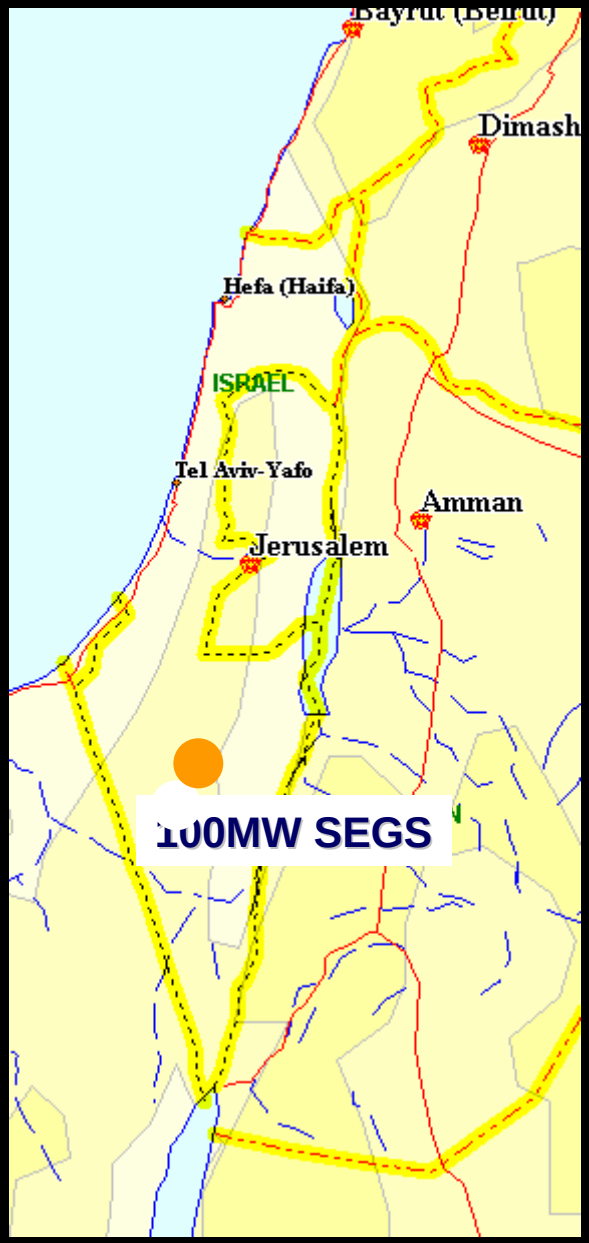
Número de licitación	18164093-022-06
Descripción del bien o de los trabajos:	171 CC Agua Prieta II (con campo solar). Clave 0518TOQ0047. "Diseno, la ingenieria, el suministro de equipos y materiales, la construccion, la instalacion, las pruebas, el apoyo tecnico, fletes, seguros, aranceles, impuestos y manejo aduanal, requeridos para tener una operacion segura, confiable y eficiente de una Central de Generacion de Ciclo Combinado denominada CC Agua Prieta II, con una capacidad neta garantizada de 535.64 MW (+/- 15%) a condiciones de diseno de verano, considerando gas natural como combustible principal. La Central estara conformada por dos o tres turbogeneradores de gas con sus sistemas auxiliares, cada uno con su respectivo generador de vapor por recuperacion de calor con sistemas auxiliares, un (1) turbogenerador de vapor con sus sistemas auxiliares, un (1) aerocondensador, todos los equipos necesarios para integrar un ciclo combinado, y un campo solar con concentradores solares tipo canal parabolico de no menos 30 MW, con todos los equipos y sistemas necesarios para generar y suministrar vapor al ciclo combinado, incluyendo la interconexion con la subestacion "Las Americas" de 400 kV, de conformidad con los terminos y condiciones establecidos en la seccion 6 (Contrato) y seccion 7 (Especificaciones Tecnicas) de las bases de licitacion; la Central estara localizada en el predio denominado "Las Americas", Municipio de Agua Prieta, Sonora, Estados Unidos Mexicanos.

- EPC financed by CFE with 50Mio USD GEF Grant
- The first CFE BOT was not compatible with GEF
- RFP published on 29-08-2006
- Deadline 16-01-2007 and Award 14-02-2007

INDIA: 140MW ISCCS with 30MW Solar

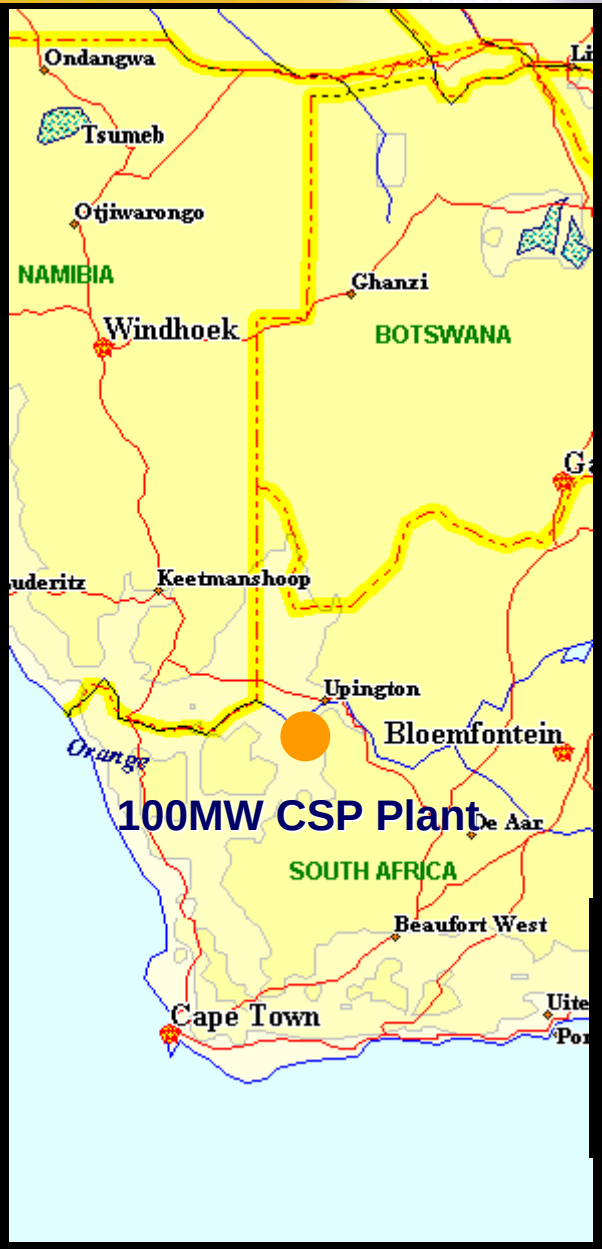


- KfW had financing with 50million USD GEF Grant
- To the RfP in June 2002 no bids were received
- In 2002 no EPC contractors ready to take the risk
- Project now on ice



ISRAEL: 5x100MW SEGS Type Plants

- Israel Ministry of National Infrastructures decided 2002 to introduce CSP in electricity market
- Objective 500MW
- Israel Public Utilities Authority studies the formulation of a feed-in law for CSP



South Africa: 100MW Power Tower

- ESKOM develops 100MW Demo Power Tower in Upington
- EPC Project of 100MW Molten Salt Tower
- Now technology risk reduction study

Key Advantages of CSP?

- The inherent advantage of STP technologies is their unique integrability into conventional thermal plants: All of them can be integrated as "a solar burner" in parallel to a fossil burner into conventional thermal cycles

- With thermal storage or fossil fuel backup solar thermal plants can provide firm capacity without the need of separate backup power plants and without stochastic perturbations of the grid.