



Large-scale rollout of Concentrating Solar Power in South Africa

Max Edkins

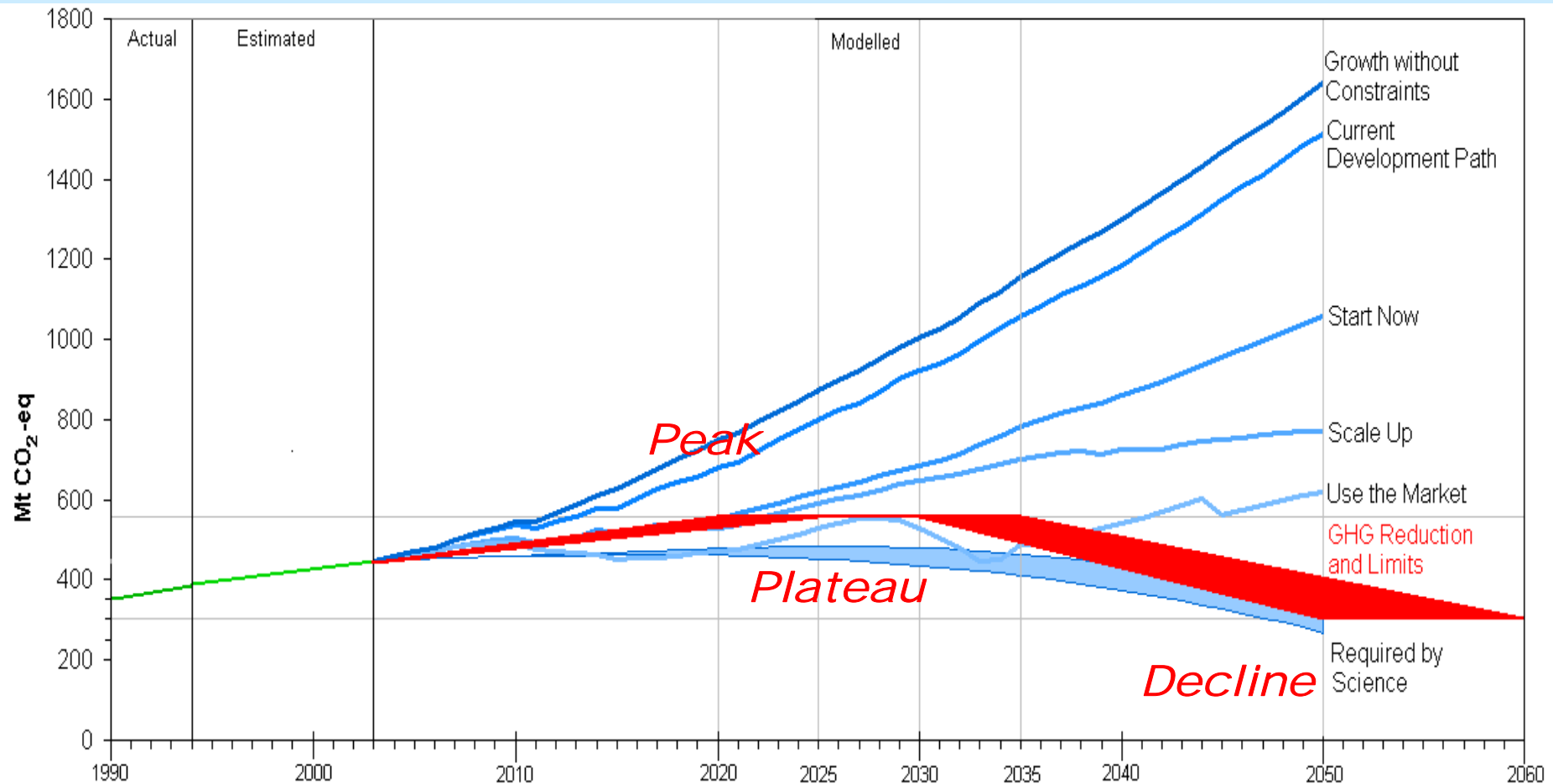
Climate Strategies Side Event • Bonn • 5 June 2009

Energy Research Centre



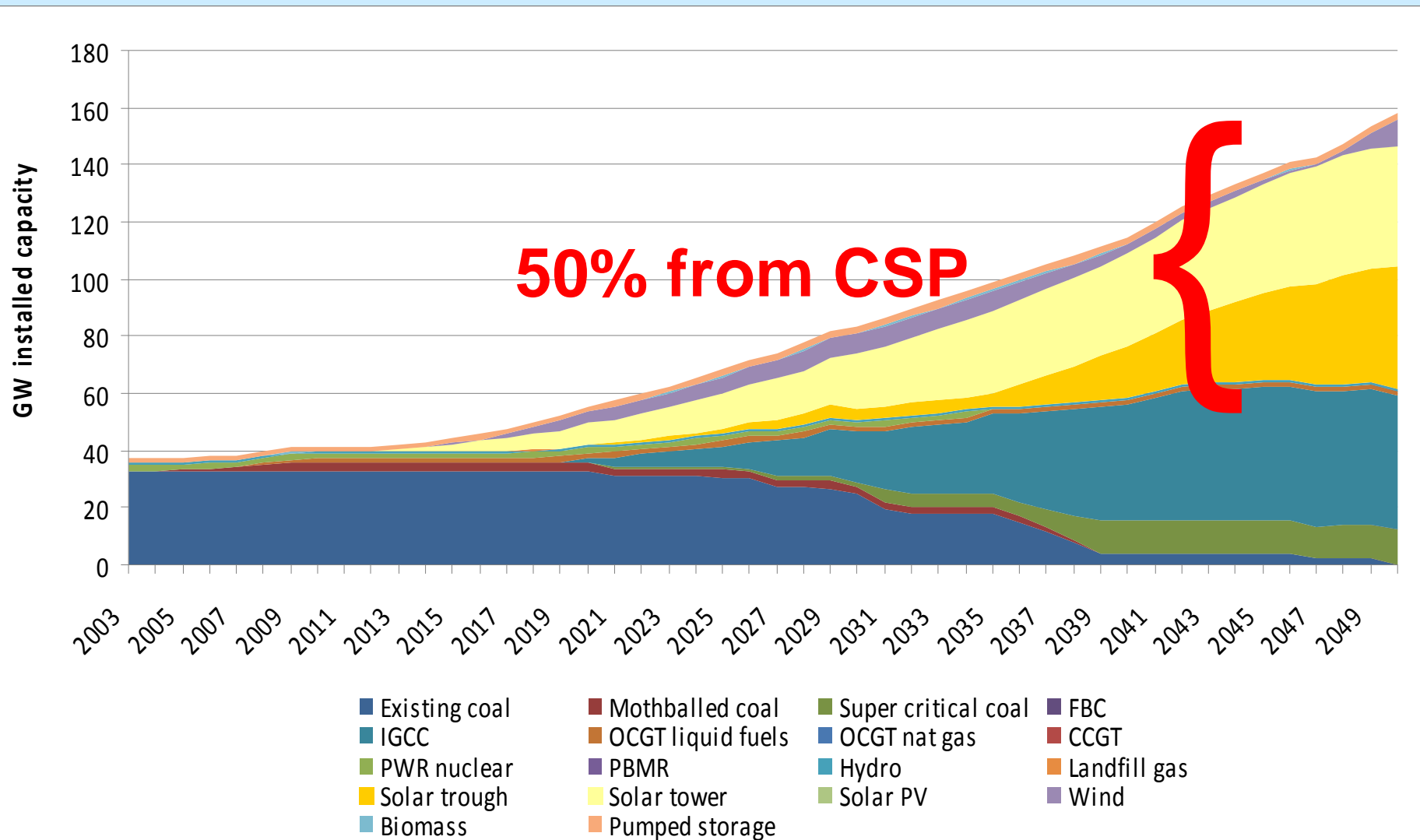
University of Cape Town

South Africa's LTMS



Source: DEAT 2008

LTMS renewables extended electricity projection



Source: Winkler 2007

Large-scale CSP rollout in the media

African Leadership, Wednesday 3 April 2015

The “African Century” is being driven by clean energy

With South Africa being the largest supplier of solar energy technology in the world, the South Africa-Namibia-Botswana Trans-Frontier Solar Park being the largest concentrating solar facility in the world and North Africa providing 60% of Europe's electricity from its solar stations, Africa's global economic ascendancy owes much to its

we forgot what our natural resources really are” responded the President and added “our re-awakening to our real natural wealth has paved the way.”

“Beneficiation is the key – we were simply processing the wrong stuff and destroying our natural heritage in the process” said the spokesperson for the African Union Energy Centre. In hindsight, one has to wonder

clean energy has unlocked Africa's potential. Things really started moving when we realised the simple fact that we could not be world leaders by being followers” noted Eskom's CEO.

Denel, South Africa's leading renewable energy technology company, has agreed to pay back all its governmental “bail-out” support from the 1990s as

Source: Lukey 2009

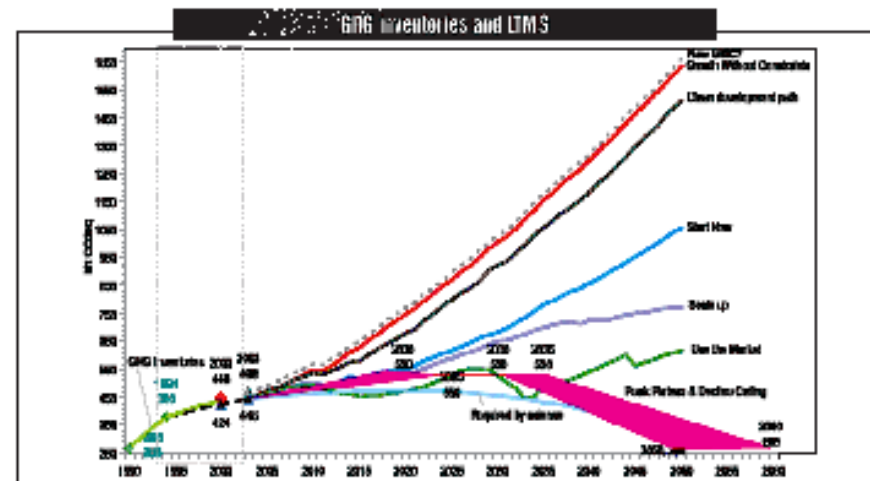
Large-scale CSP rollout in the media

The Sowetan, 29 June 2008

Climate Change - Government says “Peak, Plateau and Decline”

Government has made its position clear – South Africa’s greenhouse gas emissions must stop growing in 2020-25 and must begin to decline in absolute terms in 2030-35.

In a statement, welcomed by many climate change and energy stakeholders, the Minister presented Government’s policy directions for South Africa’s climate change response policy at a press briefing in



a courageous target that provides a real and unambiguous signal to the market” said the

Source: Lukey 2009

Large-scale CSP rollout in the media

REFIT Welcomed By Renewable Energy Sector

The publication of the renewable energy feed-in tariffs (REFIT) by the National Energy Regulator (NERSA) was met with much excitement by the Renewable Energy Sector yesterday.

tariffs are very competitive and will, without doubt, provide the investment environment that we have been waiting for for years" said SESSA's CEO.

Plans are already in place to roll-out over 1000MW of

is yet another project that is in the pipeline.

"We are ready to roll" says the CEO of AFRISOL, a solar energy company that plans to build twelve solar power stations in the Northern Cape over the

Source: Lukey 2009

Large-scale CSP rollout in the media

Engineering News, 15 June 2010

Northern Cape Solar Power Station Takes Shape

Energy reporter

"We are on track to get base-load solar power into the grid by mid-2012" says the Project Manager for South Africa's flagship solar power station.

Following the groundbreaking ceremony earlier last year, work on building the 100MW concentrating solar power station has been humming along and the plant is taking shape.

"This is an exemplary project" according to the main international donor
ing now calling itself the Solar Capital of



Upington a-buzz. "We haven't seen this much economic activity in years" says

Source: Lukey 2009

Large-scale CSP rollout in the media

The Daily Sun, Tuesday 1 March 2012

SASEWU APPLAUDS ENERGY MINISTER

The General-Secretary of the South African Solar Energy Workers Union (SASEWU) yesterday told our reporter that the announcement of the construction of a new 1,000 MW concentrated solar thermal power plant in the Karoo was "another milestone in South Africa's fastest growing industrial sector". She

Source: Lukey 2009

Large-scale CSP rollout in the media

Cape Times, Monday 12 June 2015

Employment at record levels in Northern Cape

Staff reporter

The mining down-turn in the 1980s led to massive unemployment in the Northern Cape Province with unemployment figures rising to over 30% in many areas. The lack of water and economic opportunities in the area did not help matters.

But turning the desert into Africa's biggest solar power station has dramatically changed the situation. Where there was hopelessness, there is now a new entrepreneurial spirit as employment reaches 93% and local businesses boom



as a result of blooming down-stream industries. With Upington now calling itself the Solar Capital of the World, new factories and service industries are

Source: Lukey 2009

Large-scale CSP rollout in the media

Financial Times, Wednesday 3 April 2017

“Green Energy” tag boosts exports

South Africa's global dominance in the renewable sector is now positively impacting exports of non-energy products.

According to a survey published yesterday, products manufactured in South Africa that bear the “Green Energy” tag are in high demand as consumers become far more picky about what energy source

to be expected” noted an aging Harald Winkler.

How times have changed - The Lethabo coal-fired power station monument, now matches the Voortrekker Monument as a tourism attraction that documents are recent past. “I can't believe that we used to burn fossil-fuels like there was no tomorrow” says 12 year old Turni as she carefully



Source: Lukey 2009

The four main CSP technologies



© Sandia



© Novatec



© DLR



© FVEE

C ~ 70-90
commercial

$\eta_{\text{ann}} \sim 12\%-14\%$

$\text{LEC}_{2020} \sim 5\text{ct/kWh}$

C ~ 60 – 120
demonstration

$\eta_{\text{ann}} \sim 10\%-12\%$

$\text{LEC}_{2020} \sim 5\text{ct/kWh}$

C ~ 300 – 4000
commercial demo

$\eta_{\text{ann}} \sim 14\%-18\%$

$\text{LEC}_{2020} \sim ?$

C ~ 500 – 1000
commercial demo

$\eta_{\text{ann}} \sim 10\%-15\%$

$\text{LEC}_{2020} \sim 5\text{ct/kWh}$

Parabolic Trough – Linear Fresnel – Dish Sterling Systems – Solar Tower

Source: renac 2009

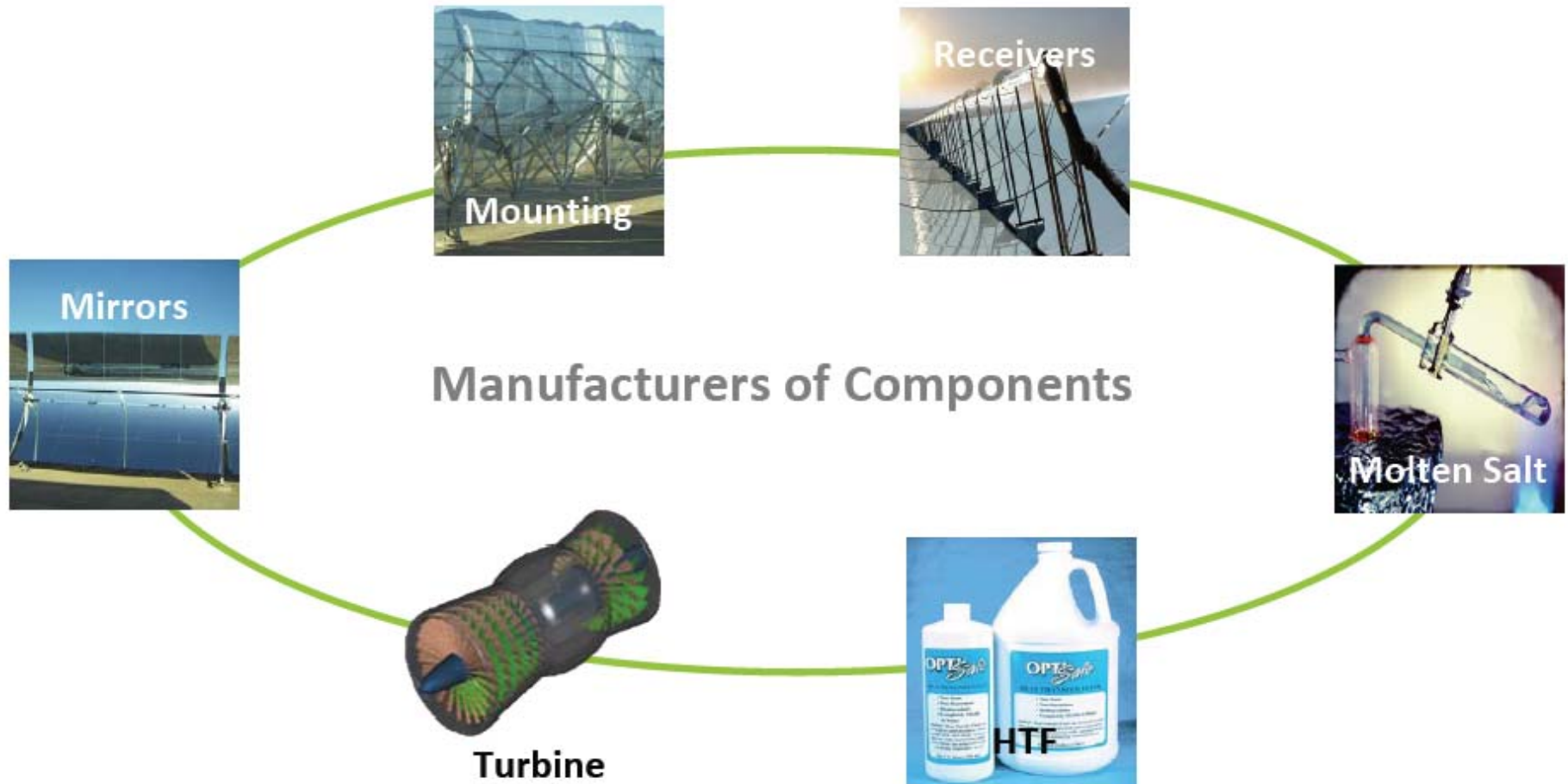
Commercial Deployment globally

TABLE 1. Summary of CST Development to 2008

Technology	In Service Capacity (MW)	Planned Capacity (MW)	Total (MW)	Leading locations (including planned installations)	Companies
Trough	395	4,967	5,362	U.S., Spain, China, Israel, Australia, Morocco, Greece, UAE, Algeria, India, Mexico, Iran	Acciona, Iberdrola, Luz (Solel), SkyFuel, Solar Millenium, Solucar
CLFR	1	1,489	1,490	U.S., Libya	Ausra, SkyFuel
Tower	11	601	612	Spain, U.S., South Africa, Egypt	BrightSource Energy, Sener
Total	407	7,057	7,464		

Source: WRI 2009

CSP components



Source: renac 2009

CSP Plant Design options

Source: WRI 2009

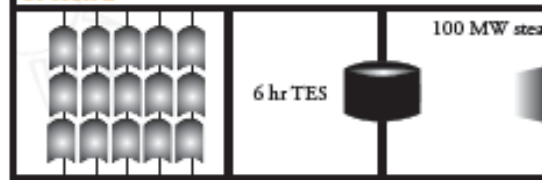
OPTION 1



1,089,920 m² solar field

200 MW turbine and no storage
Capacity factor ~23%; solar multiple = 1.25

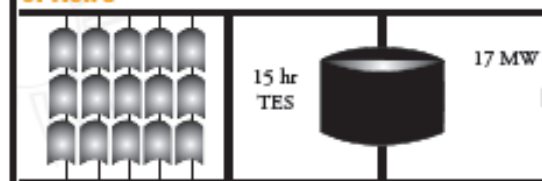
OPTION 2



1,089,920 m² solar field

100 MW trough system with 6 hours storage
Capacity factor = 40%; solar multiple = 2.5

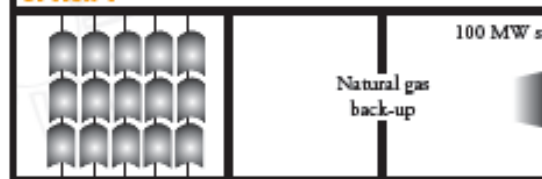
OPTION 3



1,089,920 m² solar field

Capacity factor = 65-71%
(solar tres plans 71% with minimal natural gas supplement)

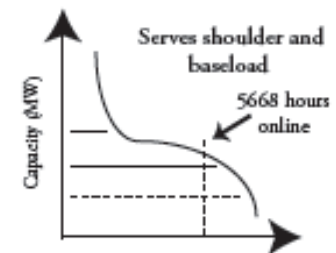
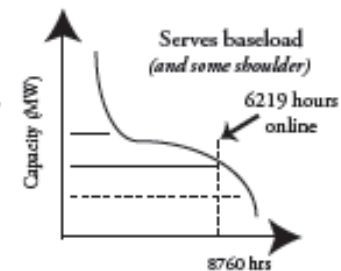
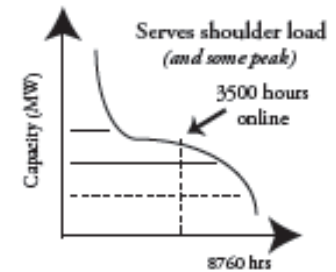
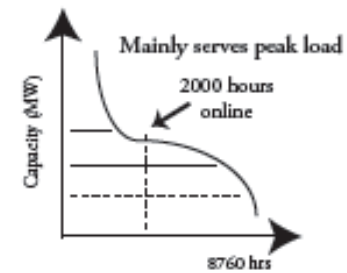
OPTION 4



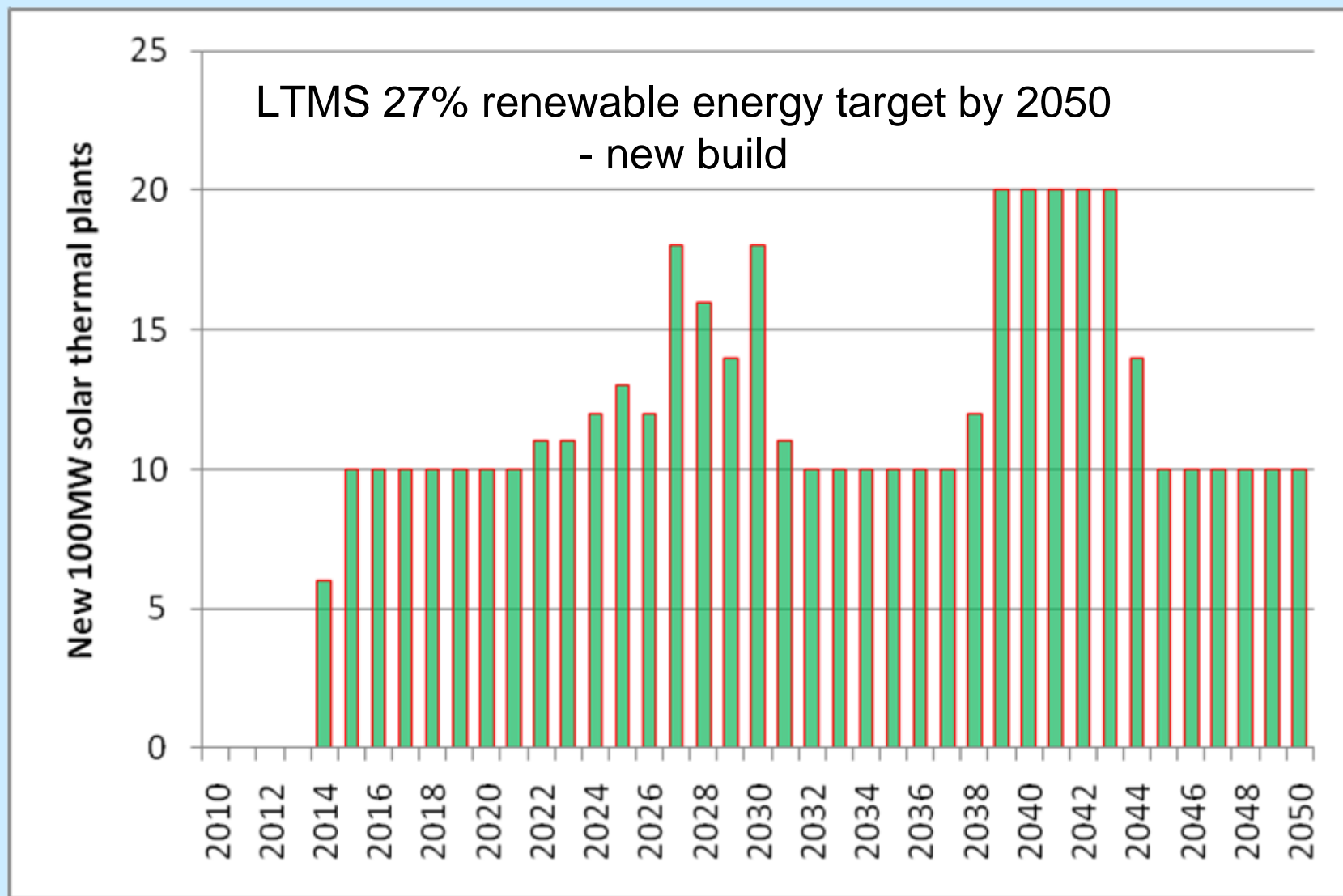
1,089,920 m² solar field

Capacity factor 65%; solar multiple ~2.5
Approximately 35% of thermal energy input is from natural gas, 65% from solar

U.S. Dispatch Curve

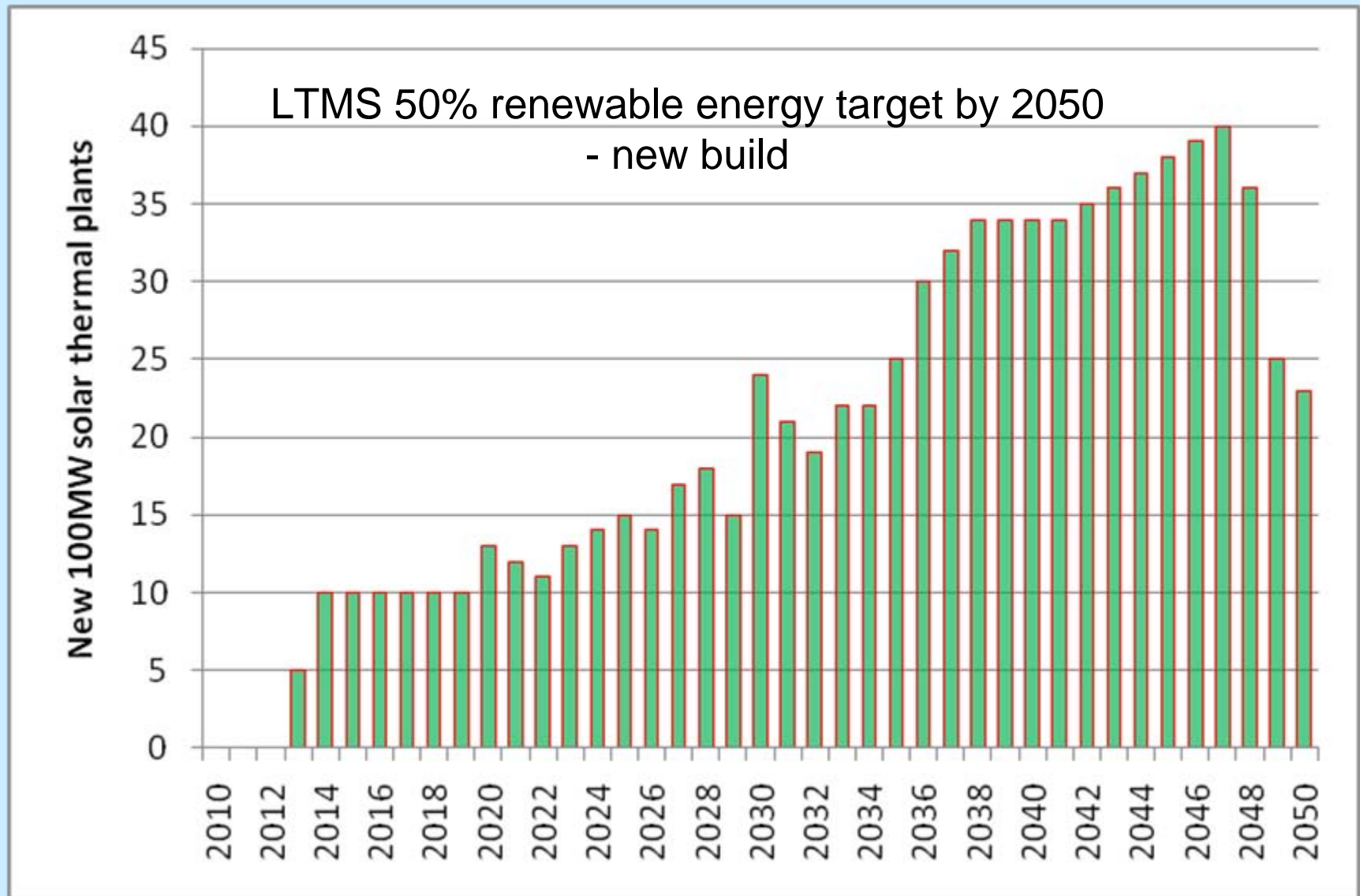


Quantifying - what is large-scale CSP rollout?



Source: Winkler 2007

Quantifying - what is large-scale CSP rollout?



Source: Winkler 2007

Quantifying - CSP Costs

Nevada Solar One

- > Built by Acciona in Nevada/USA
- > 64 MWe
- > no storage
- > Solar field: 375'000 m²
- > Invest: ≈ 266 M\$

= 2.4B ZAR/64 MW
= 3.75B ZAR/100 MW



© Acciona

Andasol 1

- > Built by ACS / Flagsol in Andalucia/Spain
- > Power 50 MWe
- > 7 hours salt storage
- > Solar field: 510'000 m²
- > Invest: ≈ 300 M€

= 3.9B ZAR/50 MW
= 7.8B ZAR/100 MW



© Solarmillennium

PS 10

- > Built by Abengoa in Andalucia/Spain
- > Power 11 MWe,
- > 30 min. steam storage
- > Solar field: 75'000 m²
- > Investment: ≈ 43 M€

= 0.6B ZAR/11 MW
= 5.1B ZAR/100 MW



© Abengoa

Source: renac 2009

Investment costs

Assuming cost reductions of 15% for every doubling of CSP capacity deployed

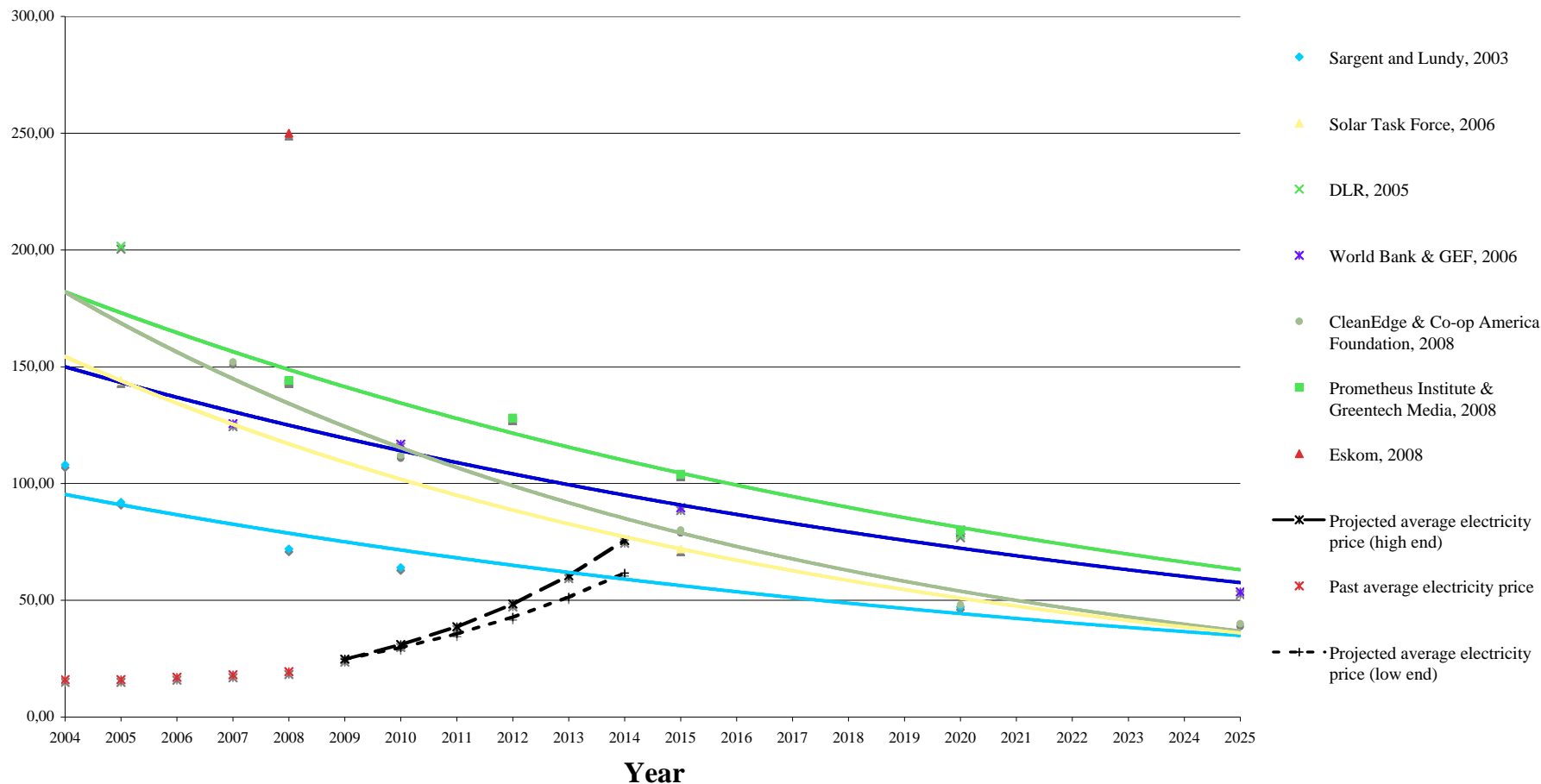
For 27% target: ZAR 30 - 50 Billion per year
(3.8 – 6.3 Billion US\$)

For 50% target: ZAR 30 - 60 Billion per year till 2030
(3.8 – 7.5 Billion US\$)

& ZAR 50 - 100 Billion per year thereafter
(6.3 – 12.5 Billion US\$)

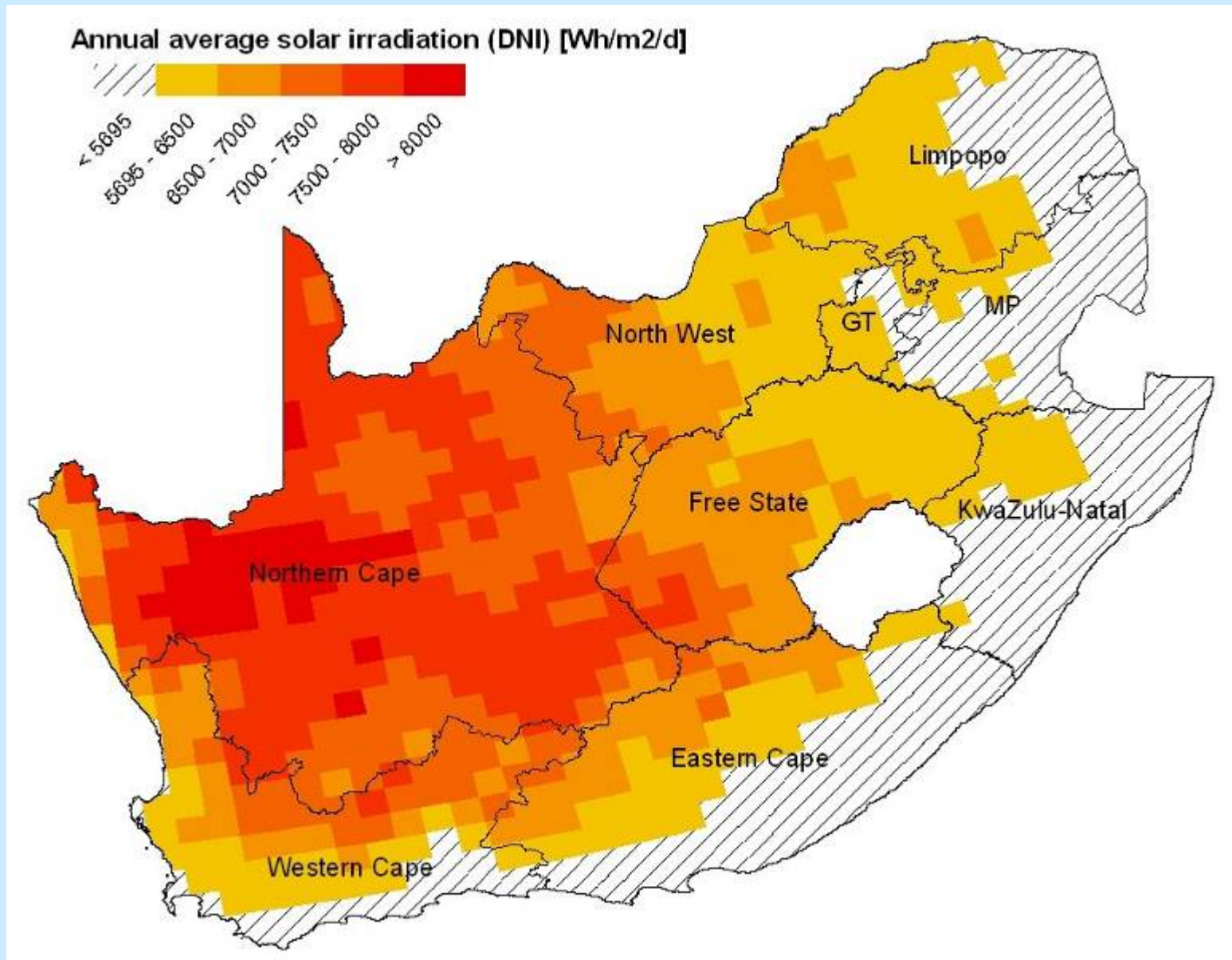
Expressed in Levelised Electricity Price (per kWh)

Cost estimates of CSP from literature (expressed in 2008 ZAR at and exchange rate of ZAR 8 to the US \$) and projected average electricity price in South Africa



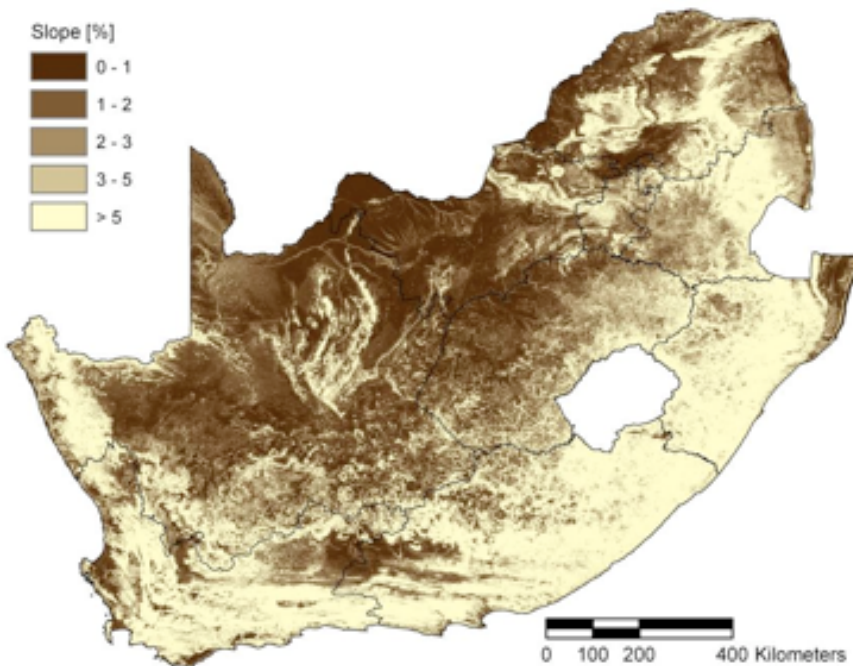
Source: Edkins 2008

Drivers for CSP rollout

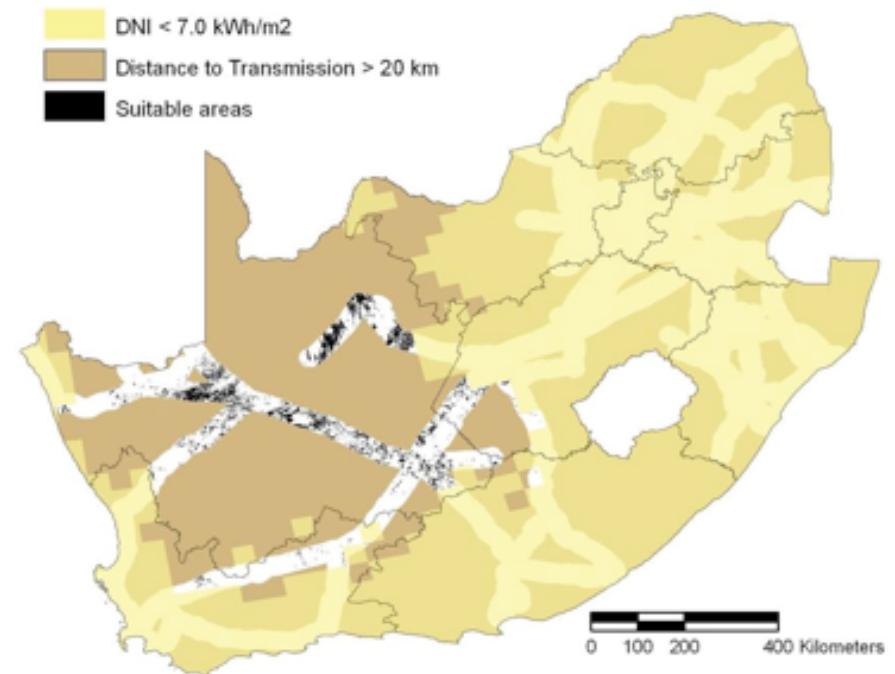


Drivers for CSP rollout

Slope (< 1 %)

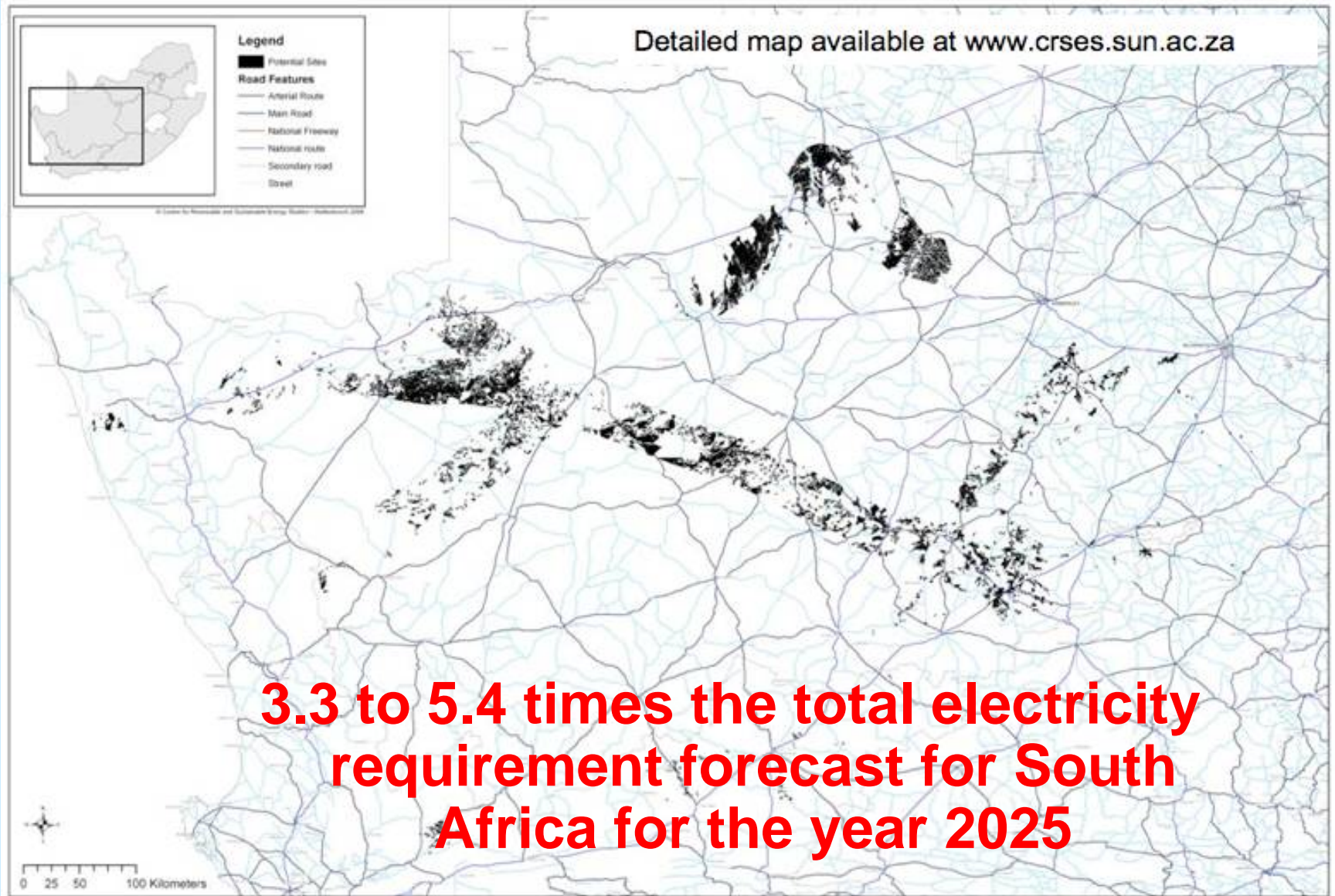


Proximity to Transmission (> 220 kV)



Data Sources: ESKOM, 2008; SWERA, 2008

Drivers for CSP rollout



Financial Driver

Since March 26th 2009

Renewable Energy Feed In Tariff (REFIT) in South Africa

For CSP = ZAR 2.10/kWh

(0.19 Euro/kWh)

Overall positively received:

70% of stakeholders surveyed thought it was “very” and “overwhelmingly” sufficient.

Stakeholder workshop



45 Participants

Government, CSP

Developers, Industry, NGOs
& Research Institutes

- 3 discussion focus groups:
Technology, Infrastructure
& Industry support
- International support &
Indicators Survey



International Support

- Financial support most valuable (76% of survey respondents):
 - Venture capital for CSP start ups
 - Feasibility studies support
 - Research support
 - Grid expansion
 - South Africa specific R&D
- Also technical support:
 - South African demonstration plants
 - Storage technology
 - Industry supply base
- And policy & institutional capacity building support:
 - Refine REFIT
 - Managerial support to REPA under Single Buyer Office

Barrier highlights

- Technology
 - “Seeing is believing” - need to complete 1st plant
 - Need to import technology
 - Storage requirement in REFIT
 - Backup fuel
- Infrastructure
 - Major grid expansion - Transmission Planning Study required - funding question
 - Water (300 000m³/year) - dry cooling will have to be used

More barriers

- Industry Development – great potential
 - Investment risk
 - Wrong branding by Eskom: ‘test plant’ should become a “solar industry development program”
 - CSP components - need planning framework for Industrial Development Zone
- Legal and Regulatory
 - REFIT vs DME bidding process – potential conflict
 - Process for PPA exists, but PPA not seen yet
 - EIA may pose to be an issue – especially water use
 - Eskom monopoly and lack of transparency

Intermediate Indicators

Intermediate progress indicator	Not at all	Not successful	Somewhat	Successful	Very Successful
GHG mitigated			←	→	
Electricity produced from CSP Plants (kWh)				←	→
CSP Plant licenses issued				←	→
CSP Plants under construction				←	→
Committed finance to CSP developments			←	→	
% of CSP in national planning process	←		→		
Amount of land and water rights committed to CSP development	←			→	
% of CSP developers engaged in South Africa		←		→	
% of CSP developers with offices in South Africa	←		→		

Thank you!

