

RENEWABLE ENERGY CORPORATION

The rapid development of crystalline silicon PV

CEEA

Dr. Erik Sauar, CTO

Singapore, November 2, 2010



SEEING IS
BELIEVING



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- Brief overview of the REC Group

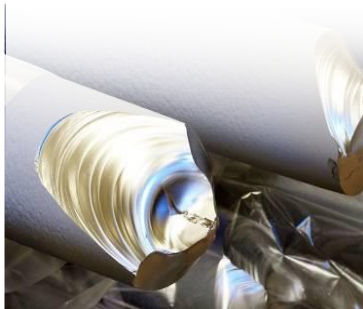
- Key factors for rapid reduction of PV electricity costs
 - By operational excellence
 - By improving technology
 - By focusing on customer value
 - By starting up world leading and competitive FBR silicon plants
 - By starting up one of the world's largest, competitive plants here in Singapore

- *Summary*

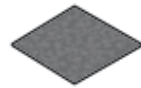
REC – an integrated PV company



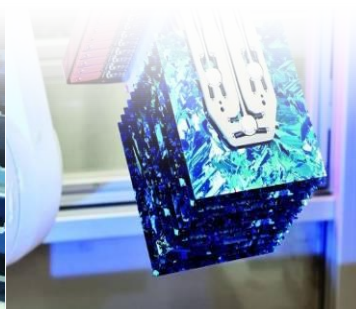
Polysilicon



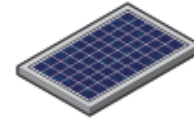
Wafer



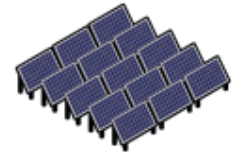
Cells



Modules



Systems



Chemical process

Casting and cutting

Surface treatment

Assembly

Project development

→ US

→ Singapore

→ Singapore

→ Singapore

→ Norway

→ Norway

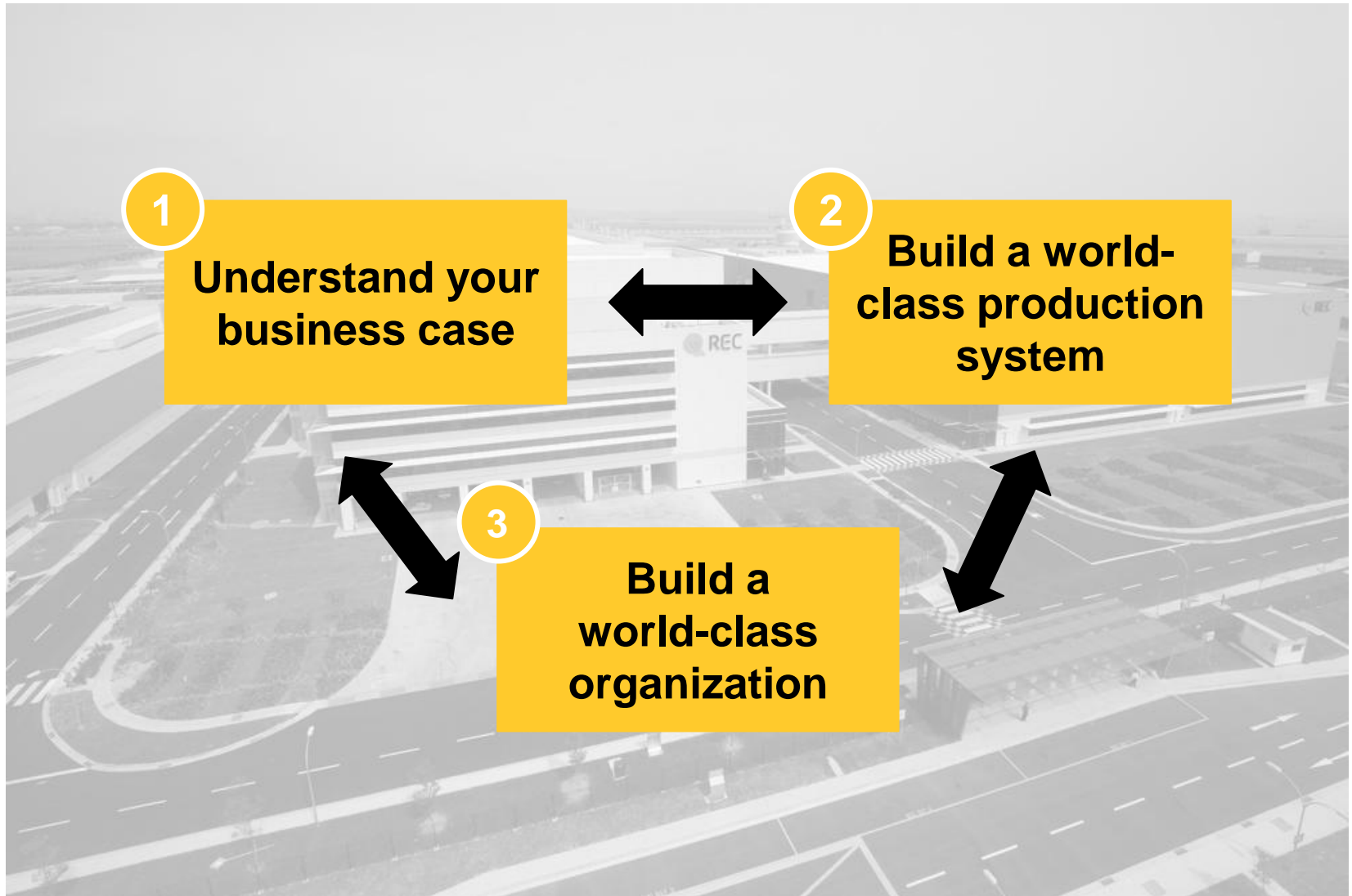
~ 13 000 tons
(2010)

~1,5 GW
(2010)

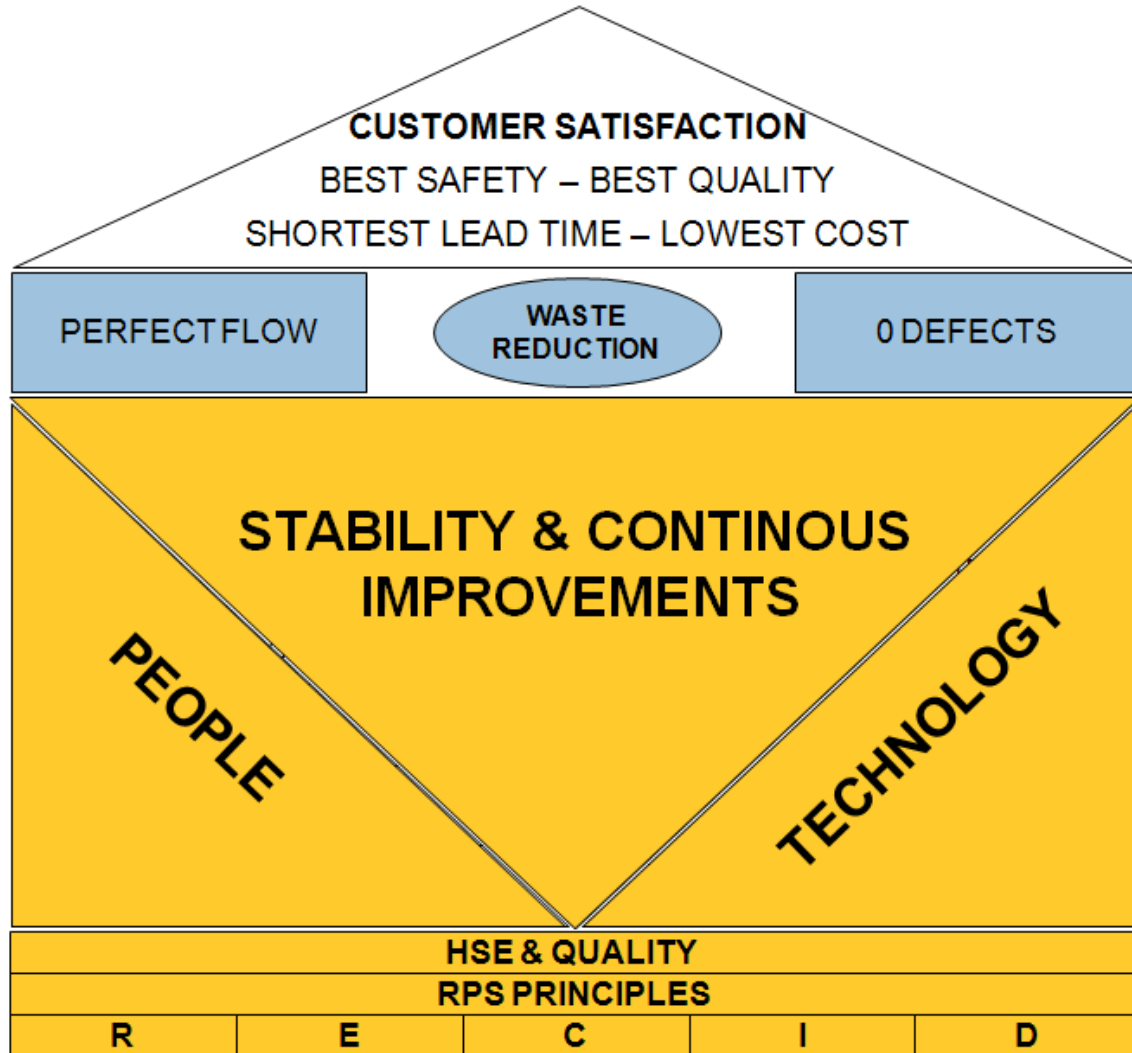
~ 500 MW
(2010)

Operational excellence:

- Success factors to create world class operations

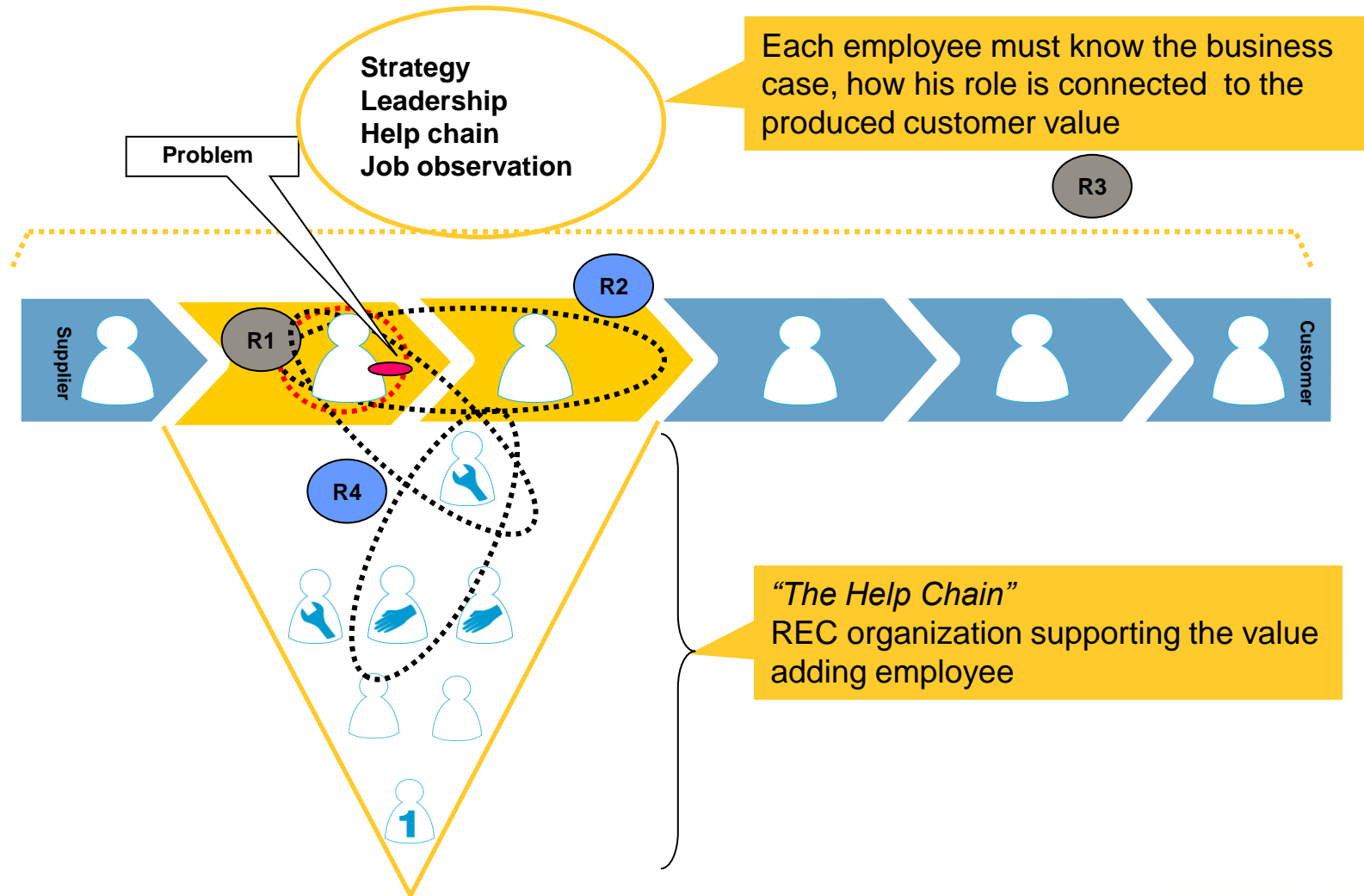


Operational excellence: - REC Production System – RPS



Operational excellence:

- Help chain supporting the value-adding employees

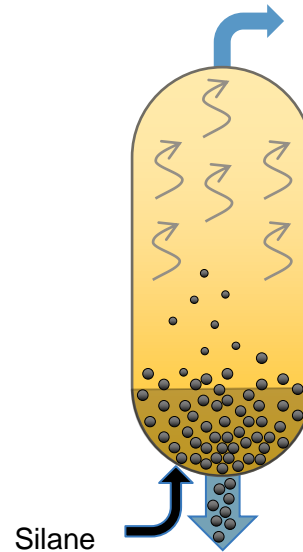


Technology achievements:

- Fluid bed technology (FBR) advantages for silicon mfr.



FBR Reactor Schematic



FBR Technology:

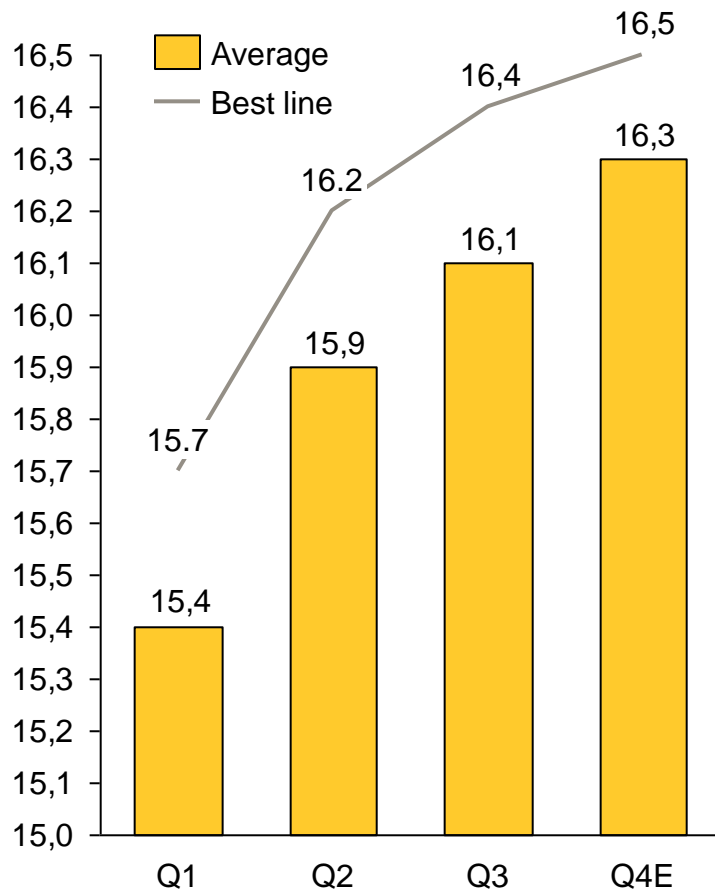
- Proprietary REC technology
- 80 – 90 % less energy consumption than Siemens
- Continuous production
- Lower cost
- Granular polysilicon is easy to handle
- Allows continuous feeding for crystallization

Technology achievements:

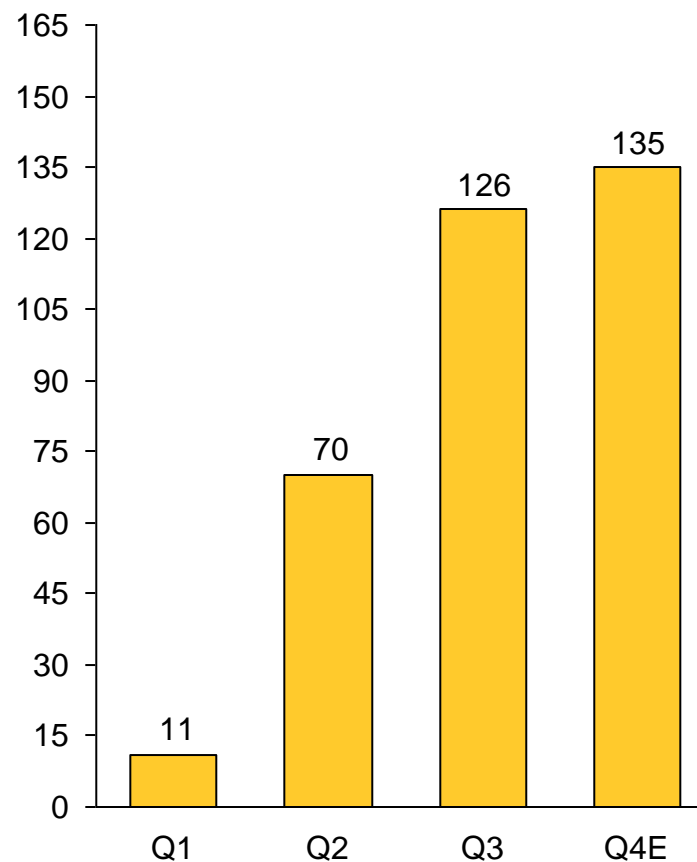
- rapidly rising cell efficiency during start-up



2010 Singapore cell efficiency (percent)

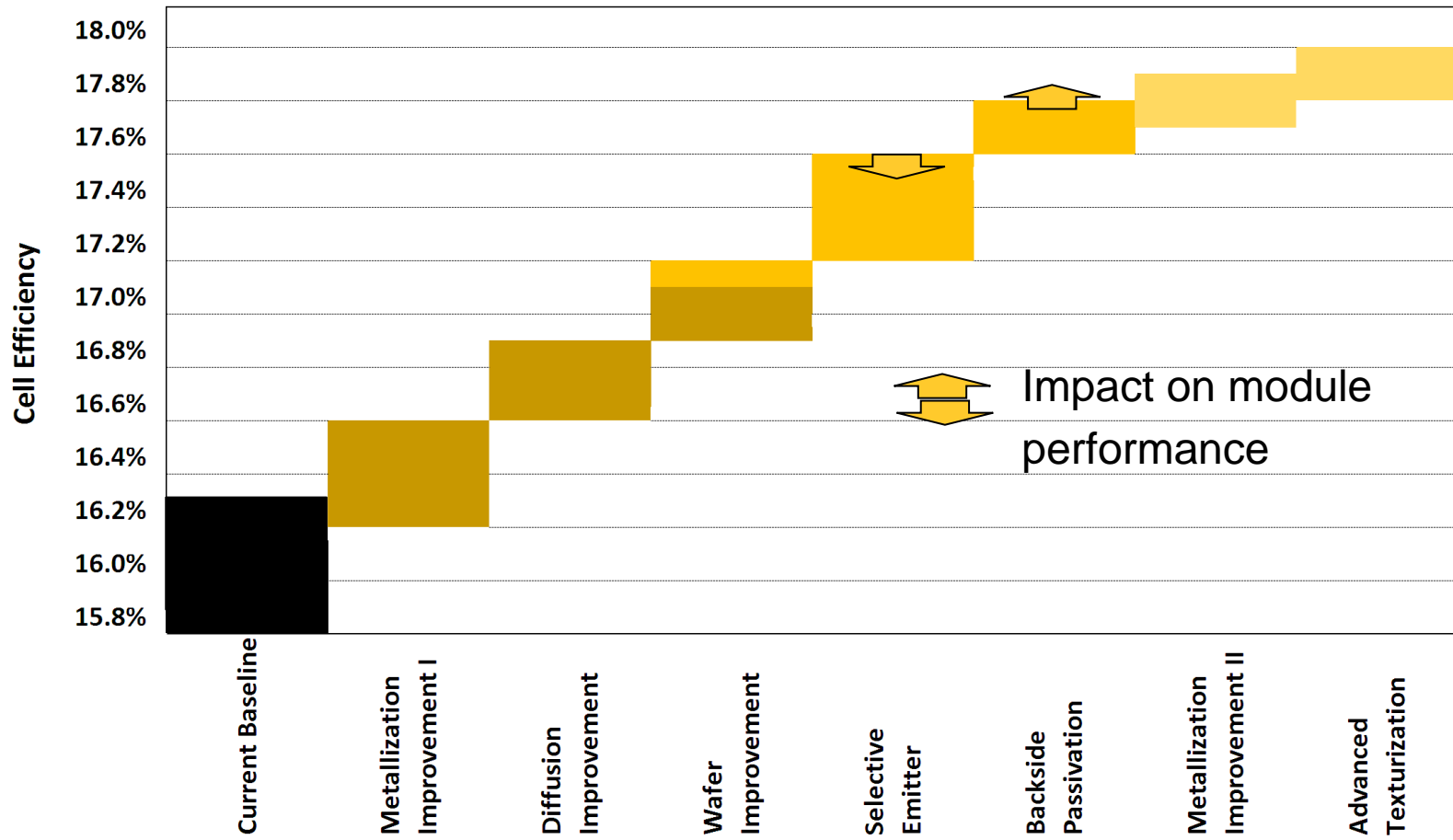


2010 Singapore module production (MW)



Technology Improvements:

- Efficiency potential of new technology steps 2010-12



Creating customer value:

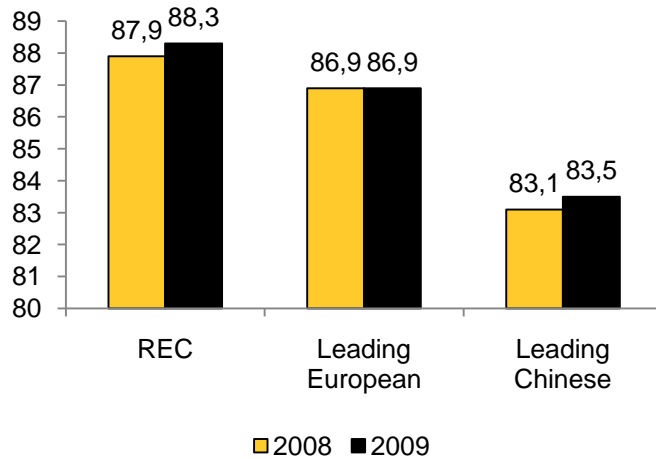
- REC modules produce more energy



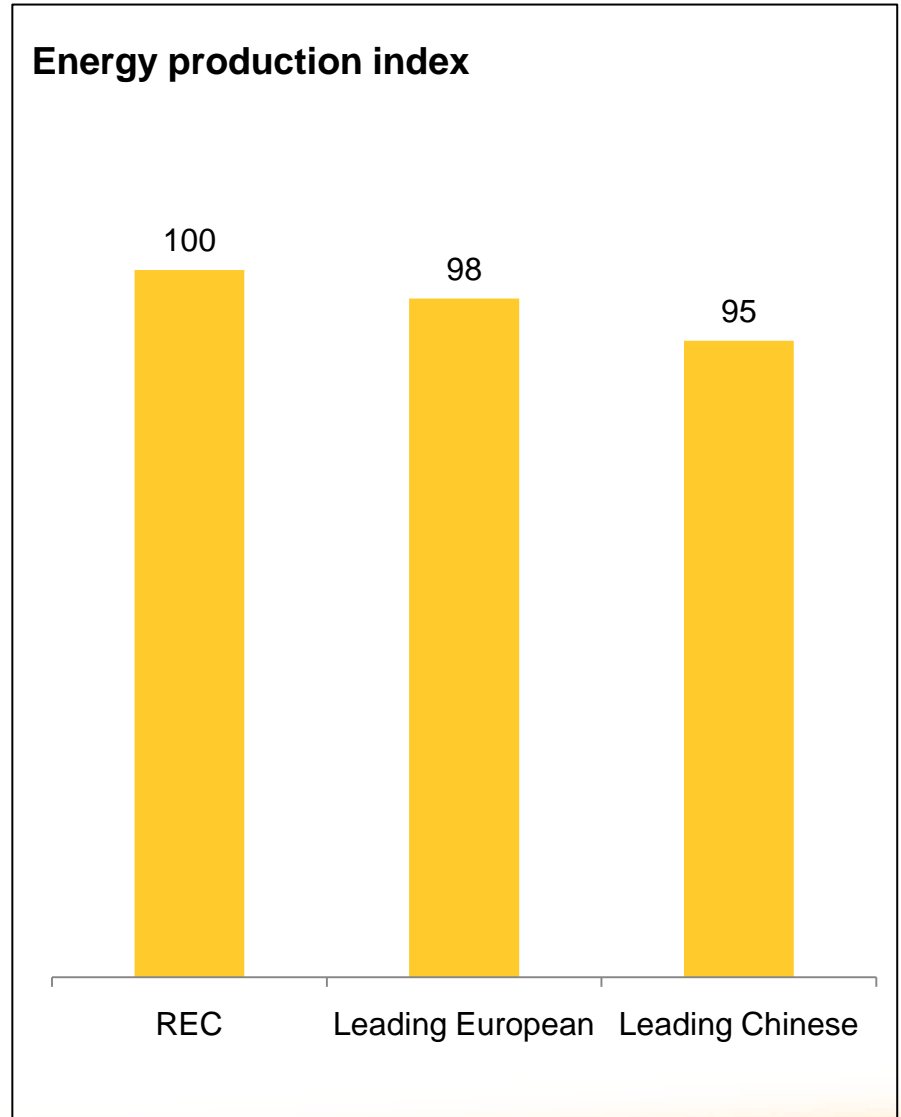
- The module plant in Singapore has an integrated glass etching line, which increases the performance ratio* of the module
- Other cell & module design elements also contribute to increase the performance ratio.
- Power output improved under all sunlight conditions: direct, sunrise/sunset, diffuse
- 2-year performance test conducted together with Fraunhofer ISE

Performance ratio %

Fraunhofer ISE



*Performance ratio: stated as percent and describes the relationship between the actual and theoretical energy outputs of the module.



REC Silicon:

- Starting up competitive FBR silicon plants in US



- FBR is proven as an energy efficient and low cost production technology
- Investment level high; new technology introduced during a heated construction market
- The Silicon III and IV plants have demonstrated their capabilities, improved operational stability required
- Already demonstrated cash manufacturing cost of 18\$/kg
- Good market response to granular quality



REC Solar:

- Starting up competitive wafer, cell, module plants in Singapore



August 2008



August 2010



Design capacity

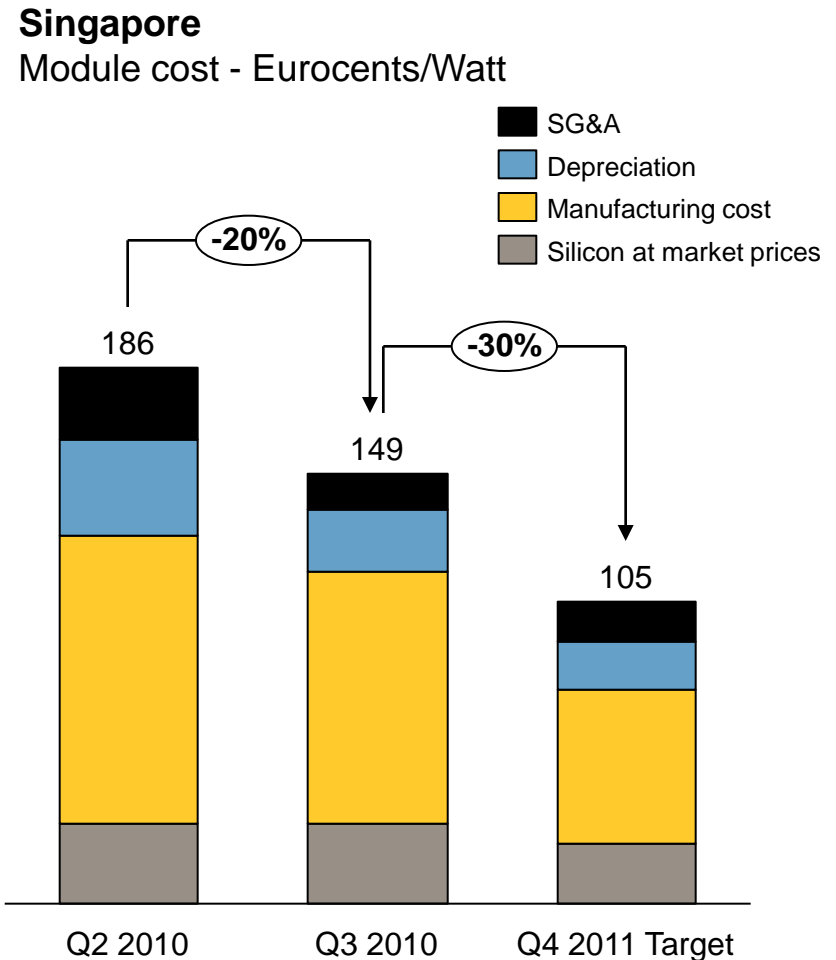
Wafers:	~740 MW	(To be exceeded)
Cells:	~550 MW	
Modules:	~590MW	

**Factory Grand Opening
On November 3, 2010.**

Singapore – Delivering above our expectations



- Highly competent workforce in well regulated society.
- The REC Singapore organization has demonstrated a strong performance in ramp-up
- Ramp-up KPIs are generally well ahead of plans.
- Improvement potentials continue to be identified
- Targeting a competitive cost position for a high quality module in 2011

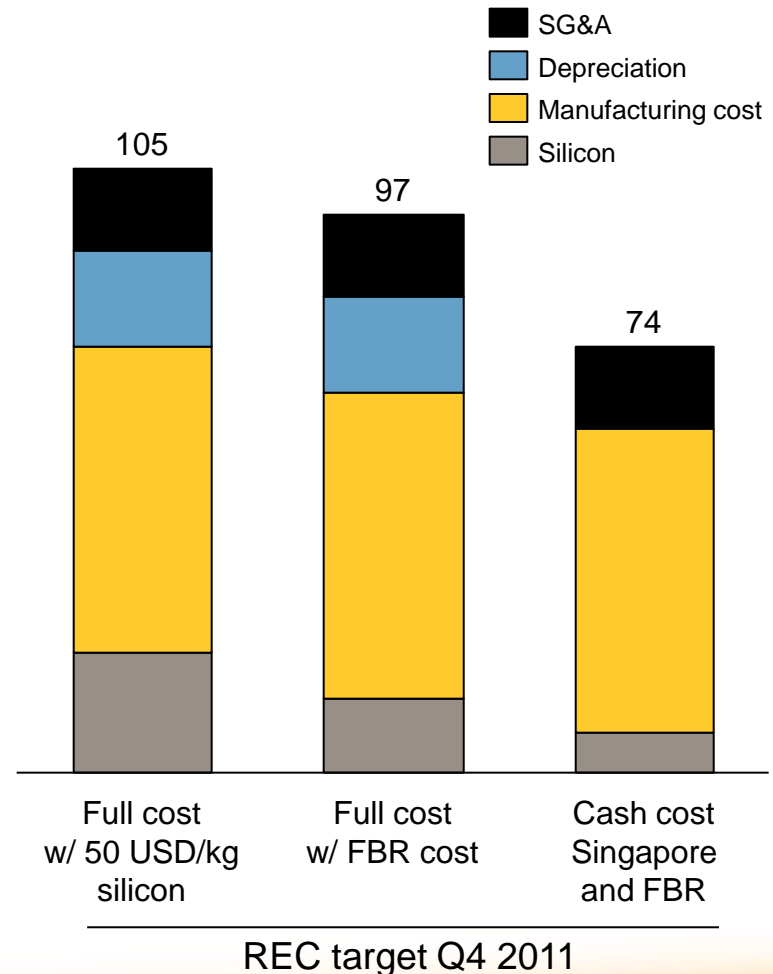


Concluding remarks

- World class production systems are vital for high speed continuous improvement of manufacturing and technology.
- Silicon based PV is still in rapid development both related to cost and technology.
- From silicon in US to module in Singapore - REC is targeting a competitive cost position
- Cost position needs to be understood in the context of product performance and selling prices.
- Our experiences with Singapore have exceeded our expectations.

Singapore

Module cost target Q4 2011 - Eurocents/Watt



A photograph of a modern, two-story residential home with a large array of blue solar panels installed on the roof. The house has a light-colored exterior and a balcony with a black metal railing. In the foreground, a family of four is enjoying a stone patio. A man in a blue shirt sits in a striped chair reading a newspaper. A woman in a white dress sits on the edge of the patio talking to a young girl in a blue dress. A boy in a light blue shirt and shorts is walking up the stone steps. A soccer ball is on the ground near the steps. The background shows a large tree and a wooden fence.

THANK YOU!

RIGHT HERE IN **CALIFORNIA**

Residential home with 61 REC solar panels installed in Monterey, California. Annual capacity: 19 435 kWh
13.1 tons of CO₂ saved annually

