



Third Silicon Conference

München, 3 April 2006

Agenda

Agenda

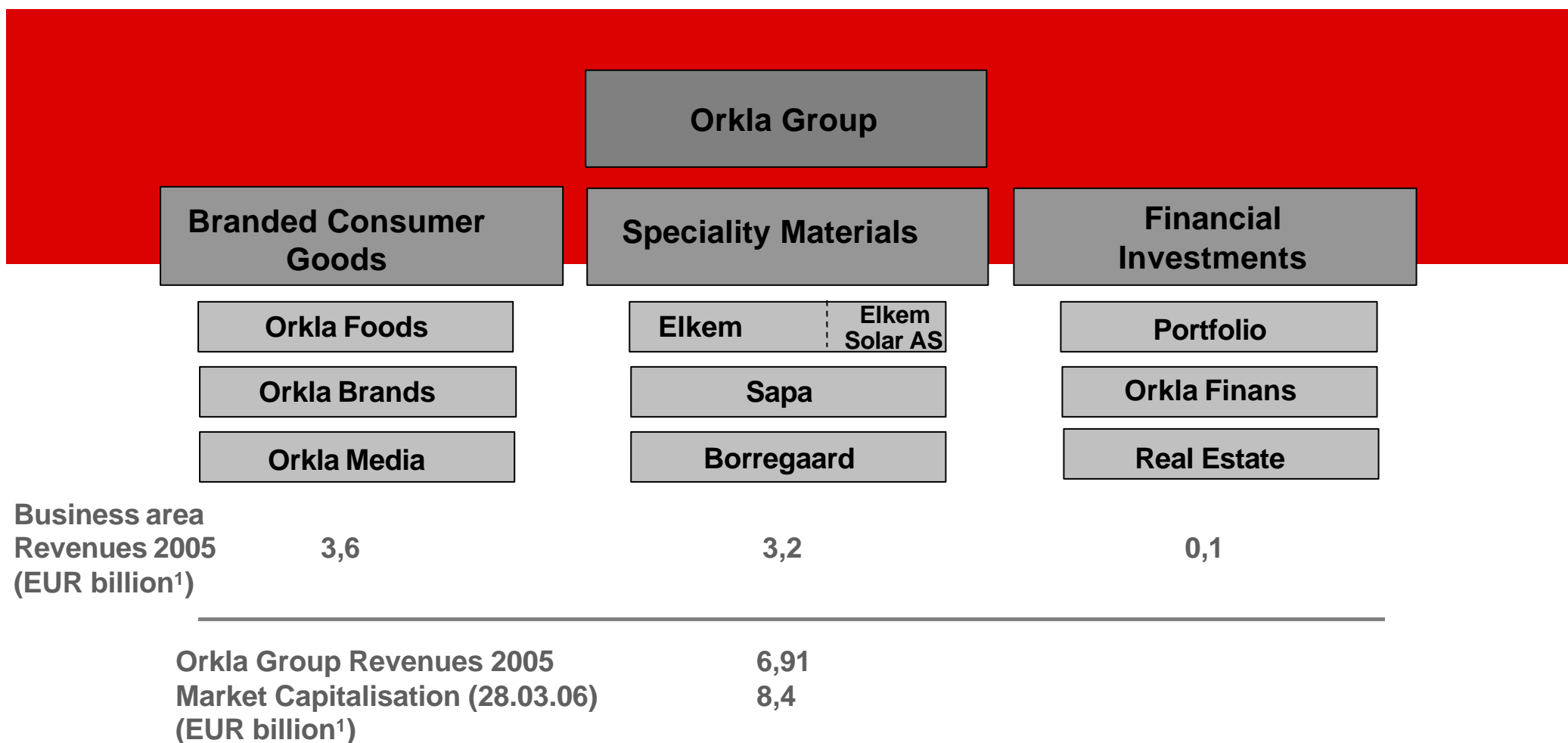
Orkla, Elkem; an overview

Elkem Solar; Metallurgical Solar Silicon

- **Most recent results**
- **The process**
- **Status and results from the Pilot Phase**
- **Next steps**

Elkem is now part of the Orkla Group

One of Norway's largest corporations



Overview

Elkem Silicon Metal business unit

Solar
Feedstock



Polysilicon
/Electronic



Chemical/
Silicones

Feil Bilde!!!

Aluminium



Elkem Salten



Chemical /
Aluminium

Elkem Thamshavn



Chemical

Elkem Fiskaa Solar



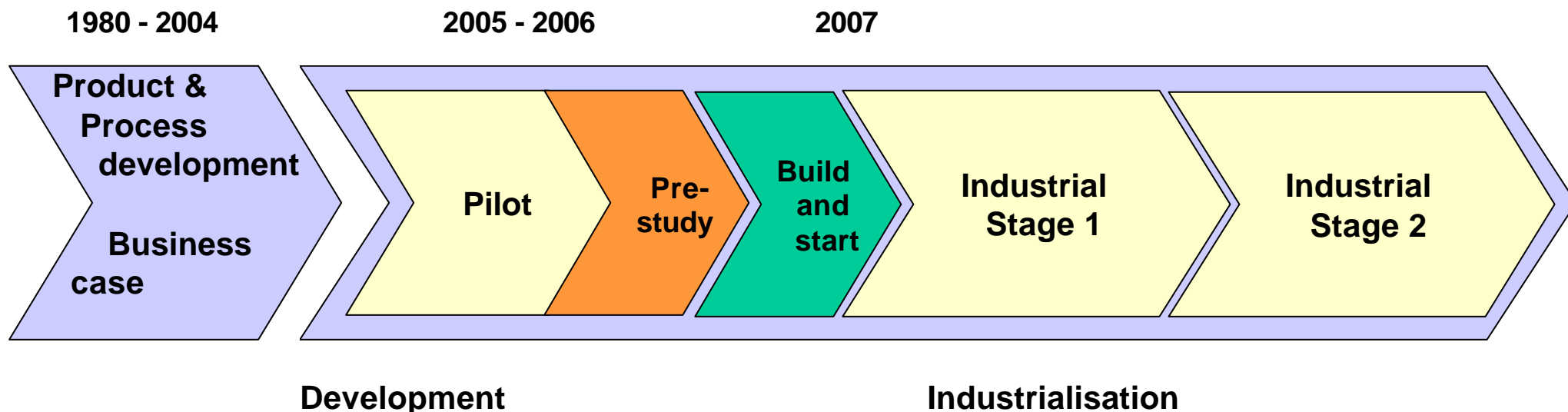
Elkem Bremanger



Electronic

ELKEM SOLAR MASTERPLAN

Industrialisation in 2007



In 2005, the team at Elkem Solar has concentrated on

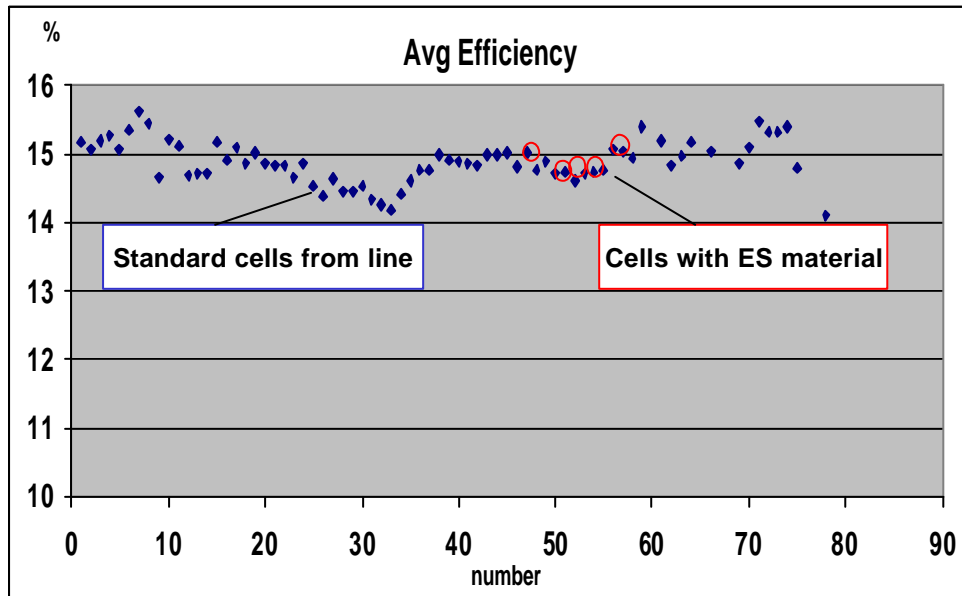
- ✓ **Verifying product quality vs customer needs**
- ✓ **Verify process scale up**
- ✓ **Preparing an engineering pre-study**

Elkem Solar Team in rapid development

- ✓ **38 employees today**

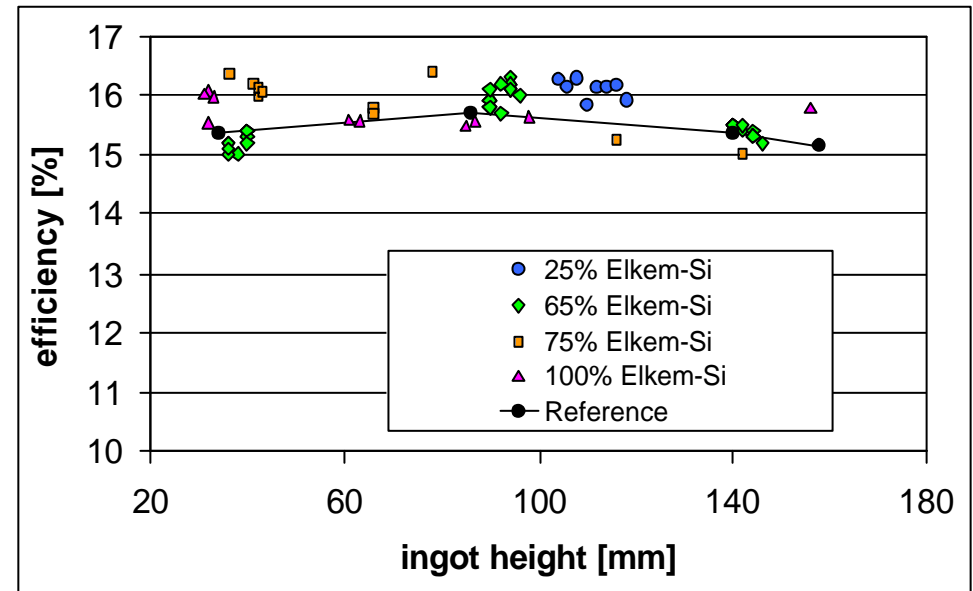
PRODUCT QUALIFIED ON INDUSTRIAL LINE DATA CONFIRMED BY PARALLEL CELL PROCESSING AT UKON

Product qualified on industrial line....



- **Verification: > 50.000 cells tested and qualified for release to market**
- **Product qualified for commercial supply**

...results confirmed in UKON lab



- **Verification at Uni Konstanz confirms results from industrial line**
 - **Efficiency**
 - **Degradation**
- **Extensive characterisation provides understanding of further potential**

ABOVE 18% EFFICIENCY WITH LITHO CELL PROCESSING AT UKON - CERTIFIED BY FRAUNHOFER ISE

**Photolithography based
solar cell process**

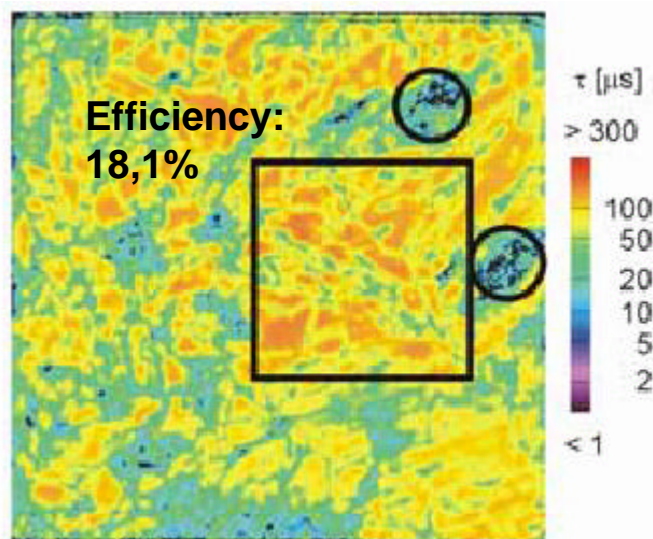


Fig. 3: Bulk lifetime mapping of a 12.5x12.5 cm²

**Record results suggest that efficiency is
limited by applied cell process rather than by
feedstock material properties**

Silicon Feedstock	V_{oc} [mV] (Average)	j_{sc} [mA/cm²] (Average)	FF [%] (Average)	η [%] (Average)
100% ES, mc UKON	642	35,3	79,9	18,2
100% ES, mc FH ISE¹	641	35,1	80,3	18,1
0,75 Wcm FZ UKON	638	36,0	78,9	18,3

1) Results certified by Fraunhofer ISE in Freiburg

1st CZ MONOCRYSTAL PRODUCED AT INSTITUT FÜR KRISTALLZÜCHTUNG (IKZ) IN BERLIN



First tests on CZ provide encouraging results

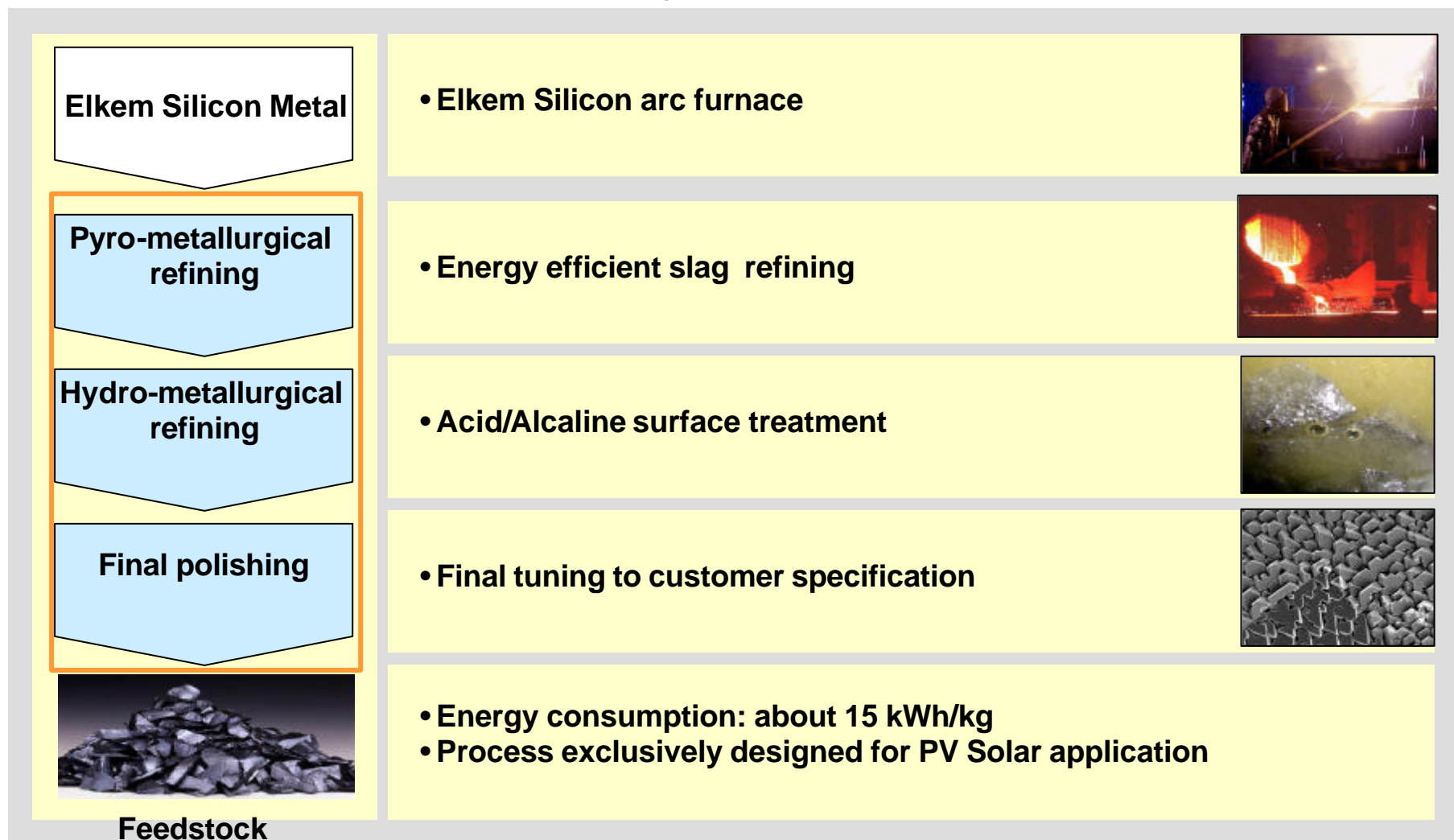
- **Homogenous monocrystalline ingot**
- **High lifetime**

Program continues with high priority

- **Industrial scale CZ**
- **Tests on Float-Zone (FZ) process**

COST EFFICIENT METALLURGICAL REFINING PROCESS

Process capability demonstrated in pilot plant



Feedstock

2005: SUCCESSFUL SCALE-UP DEMONSTRATED IN PILOT PLANT



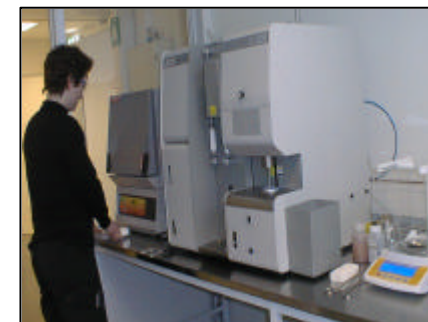
Pyrometallurgical
treatment unit



Hydrometallurgical
treatment unit



Finishing for shipment
in white-room
environment



QA in dedicated solar lab

- ICP-MS
- ICP-OES
- LECO
- Halleff/Res

Challenge

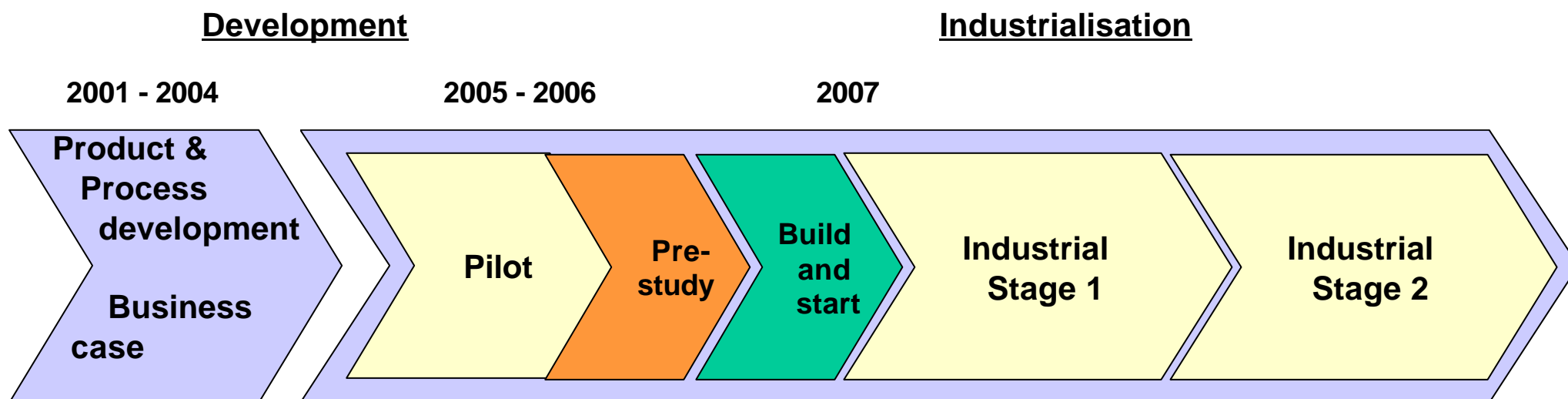
Confirm successful scale up to industrial design dimensions on critical equipment

Results

- Critical process equipment has been built in industrial scale while keeping the auxiliary systems to a necessary minimum
- Satisfactory quality and repeatability in all steps demonstrated in numerous test runs. Some minor verification remains
- Collected valuable operating experience
- Process considered ready for industrialization

ELKEM SOLAR MASTERPLAN

Industrialisation in 2007



Industrialization plan on track

- ✓ Product qualified for commercial supply
- ✓ Industrial process capability demonstrated in pilot unit
- ✓ Pre-study finalized, site selected
- ✓ Investment decision expected in Q2 2006
- ✓ Lead-time Stage 1: 15 - 18 months

Prepared for rapid ramp-up

- ✓ Lead-time subsequent expansion: 12 - 15 months

PREPARING TO BREAK GROUND FOR 1ST INDUSTRIAL FEEDSTOCK UNIT KRISTIANSAND

Administration

- Elkem Solar AS
- Elkem Global Research Centre

Pilot Plant (Large-Scale Tests)

Si furnaces

Elkem Solar
• Industrial plant site

