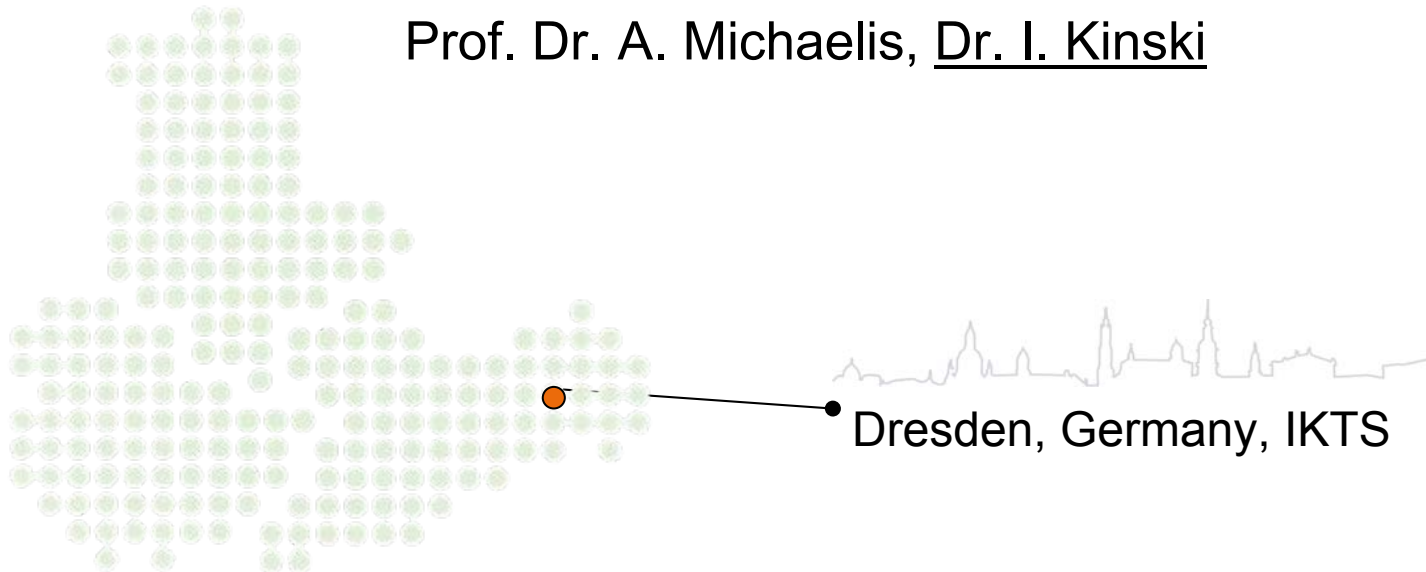
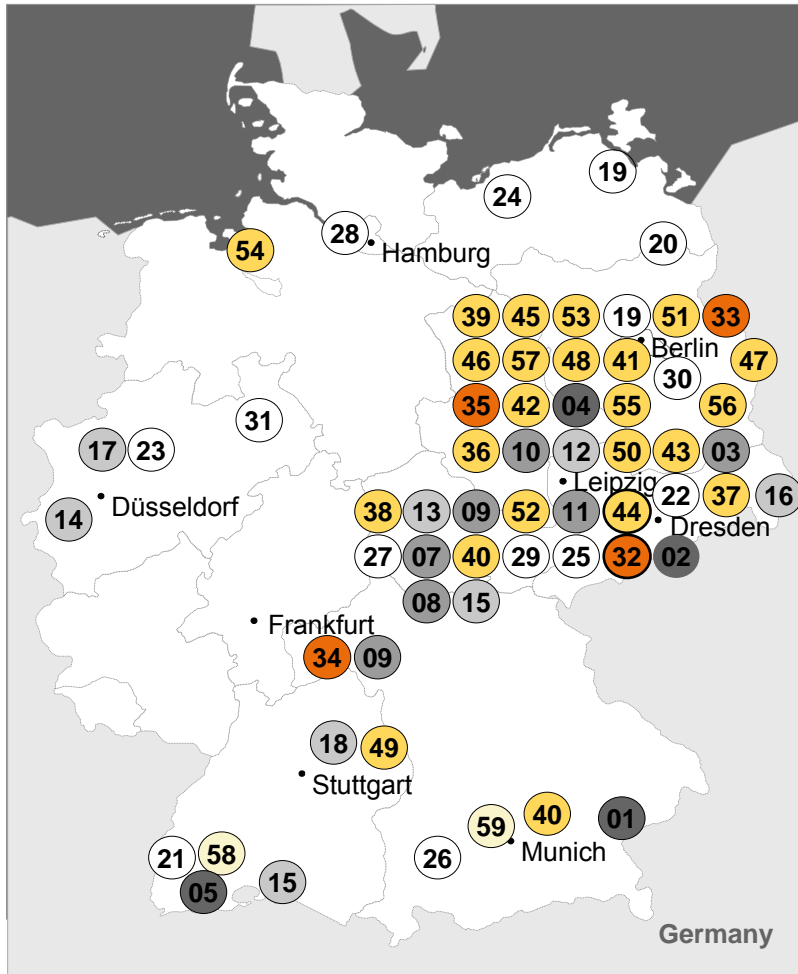

Solarvalley Central Germany and Renewable Energies and Energy-Efficiency Systems at Fraunhofer IKTS

Prof. Dr. A. Michaelis, Dr. I. Kinski



Solarvalley Central Germany – Technological advance by regional collaboration



- 65% PV companies located in Central Germany
- Research, development, production
- 18% of worldwide solar cell production
- 4 companies listed in world top 10
- 8500 direct employees in PV industry
- growth rate of companies > 30%

Source: Invest in Germany Research 2008, EuPD 2008, Photon 2008

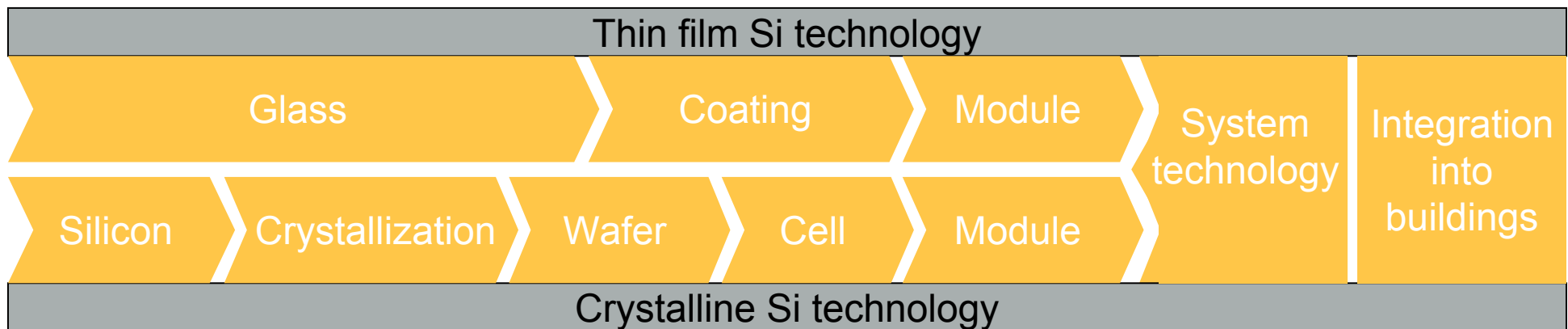
Slide 2

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Solar Energy – Crucial factor on the energy market

Innovation strategy

- Cooperation along the entire PV value chain
- Concept of development from fundamental research to innovative application
 - ➔ 27 Global operating companies
 - ➔ 7 Renowned Research Institutes
 - ➔ 4 Universities
 - ➔ 3 Federal states



Slide 3

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Acceleration of Innovations – Integral concept throughout cluster of excellence solarvalley

Matched R&D program for the entire value chain:

Cost reduction for components
efficiency increase in this model

Integral modern education concept for photovoltaics:

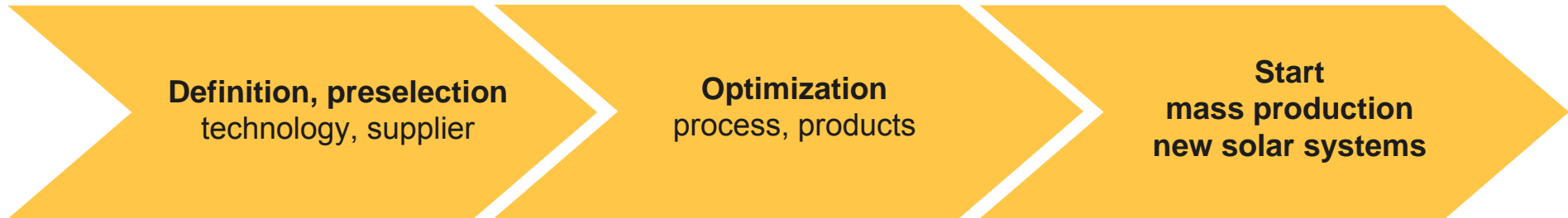
Competence center for vocational and professional training
New Bachelor- and Master program, foundation professorship

Development of a state-connecting network:

Solarvalley Central Germany e.V. with regional offices in
Dresden, Erfurt and Halle

International
leading
PV cluster

Electricity for future generations – Technology and products leading to net parity



Milestones 2011

- Materials cost reduction > 30%
- Efficiency crystalline solar cell > 20 % (equates with 25% increase)
- Thin film > 10 % (equates with 30% increase)
- Reliability and module warranty \geq 30 years (equates with 20% increase)

Political conditions in Thuringia

- 10 million € R&D joint projects
- SolarZentrum Erfurt as additional institute of TU Ilmenau
- Center of Spectroscopy at IMN Ilmenau
- Focus on thin film at IPHT

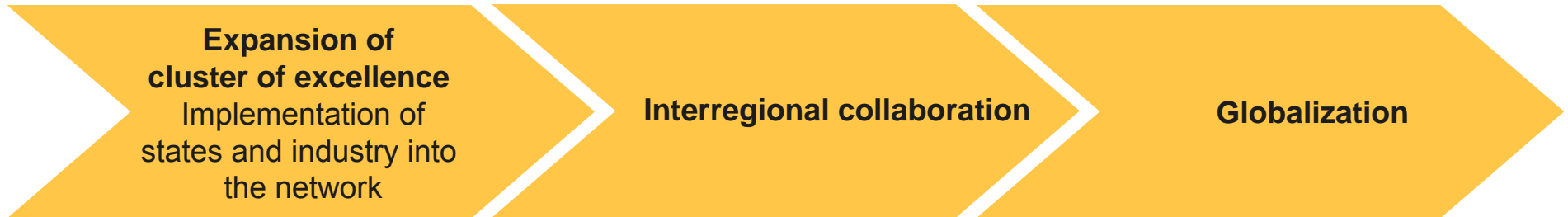
Economic growth by vocational and professional training – new jobs



Milestones 2011

- Professional qualification: 5.000 skilled workers
- Recruiting of experts outside of Central Germany: 2000
- Network of academic education (Bachelor, Master): 400 graduations / year
- Doctor's degree: 40 graduations / year
- National and international partner

High-Tech in Central Germany – Region for PV with high attractiveness for economy & society



Milestones 2011

- PV communication platform, monitoring of success of the innovation process
- New PV applications
- Cross-linked research infrastructure
- Set-up and establishment for suppliers, allocation of areas for building development

Fraunhofer – Institute for Ceramic Technologies and Systems IKTS Dresden

Regular staff:	218
Student workers:	47
Total budget:	€ 20.8 million
Industrial revenues:	41.3 %
Public research revenues:	38.9 %
Core financing:	20.6 %
Area:	102 laboratories and pilot plants of approx. 9400 m ²
Institute director:	Prof. Dr. Alexander Michaelis



www.ikts.fraunhofer.de

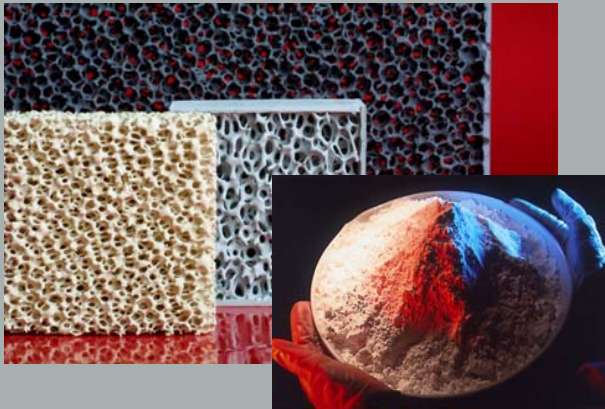


Profile of Fraunhofer IKTS – Business Units

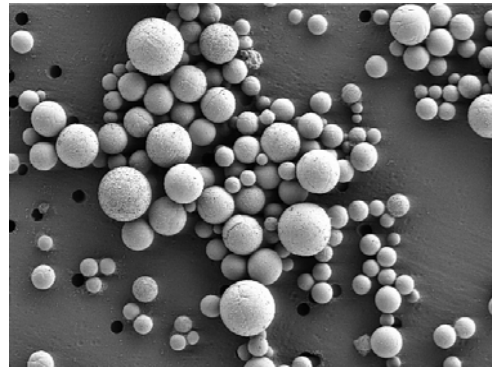
Structural Ceramics

Functional Ceramics

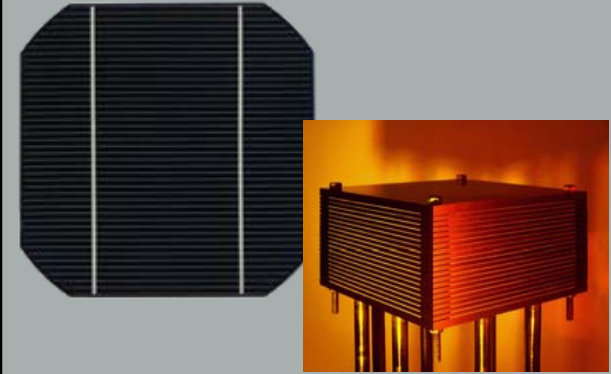
Materials



Sintering /
Characterization



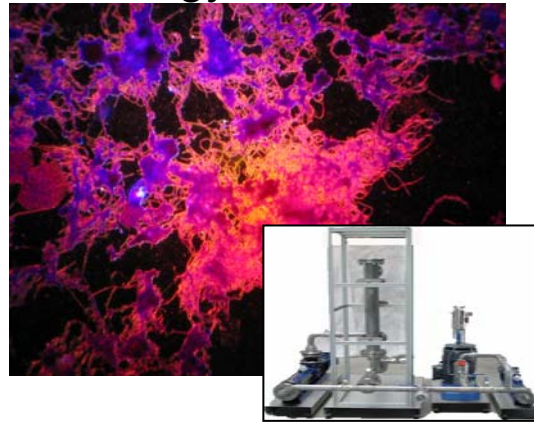
Micro and Energy Systems



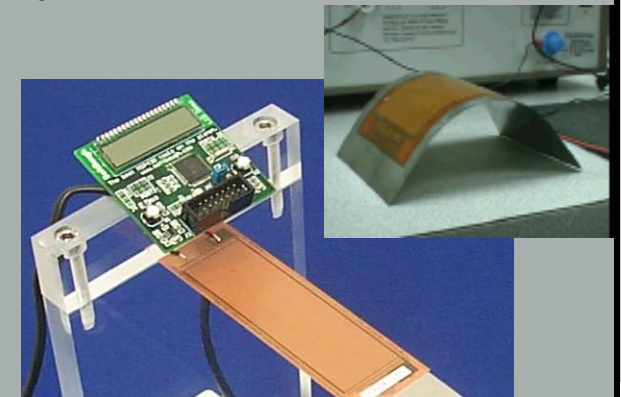
Process/Components



Environmental Processing
Technology



Smart Materials and
Systems



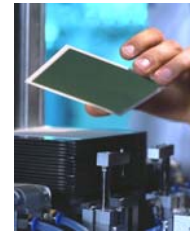
Slide 9

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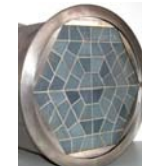
Renewable Energy at IKTS

Research Activities:

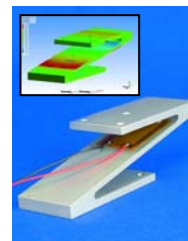
- ▶ Development of Materials and Processes for PV application
- ▶ System solution for efficient biogas production
- ▶ SOFC: from mW to kW application
- ▶ Development of small fuel cell systems (SOFC, PEM)
- ▶ Membrane and Filter Technology (Diesel Particulate Filter)
- ▶ TEG (Thermoelectric Generators)
- ▶ „energy harvesting“ (Piezoceramics)
- ▶ Battery Technology (Li-Ion)



Ceramic fuel cell stack



Filter segment with specific filter design



Force transducer for small, dynamical forces

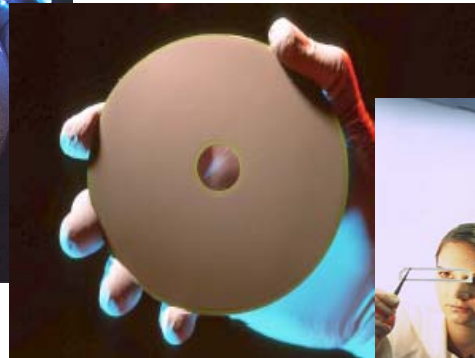
IKTS – SOFC Systems

Competency on entire production line

Materials (raw materials:
Sintered ceramics)



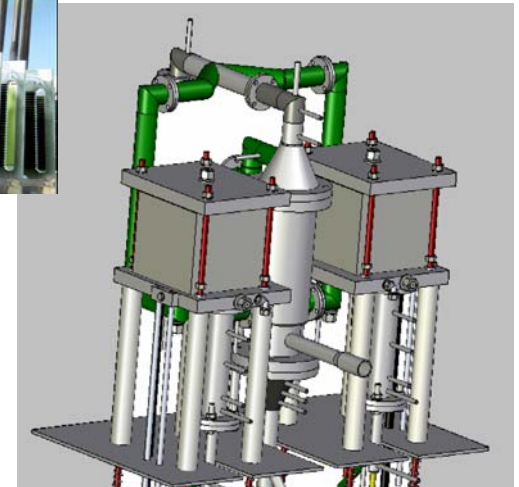
**Membrane Electrode
Assembly**



Stack



System
(Reformer [H₂+CO],
stack and burner)



- ▶ over 20 Patents
- ▶ > 30 Industrial projects since 1992
- ▶ Take-over of planary SOFC technology of Siemens AG in 1998

From materials to systems – From laboratory scale to small batches

IKTS – LTCC-based micro fuel cell charging station



Cameras



Camcorders



PDA

Laptops



Mobile Phones

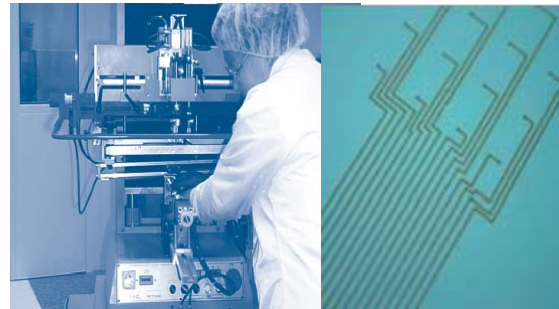
From materials to systems – From laboratory scale to small batches

IKTS – Functional materials

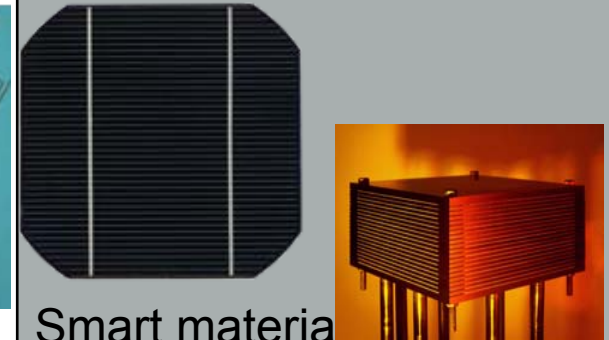
1 Pastes / thick film technology



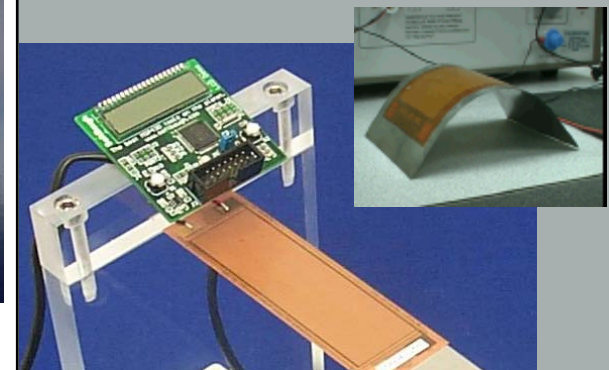
2 Tape casting, screen printing



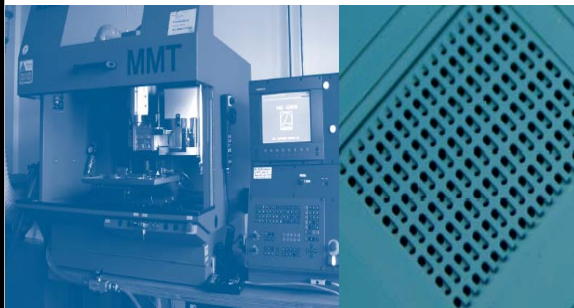
Micro and energy systems



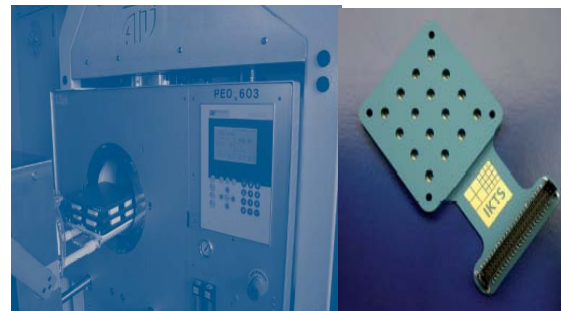
Smart material systems



3 Stacking

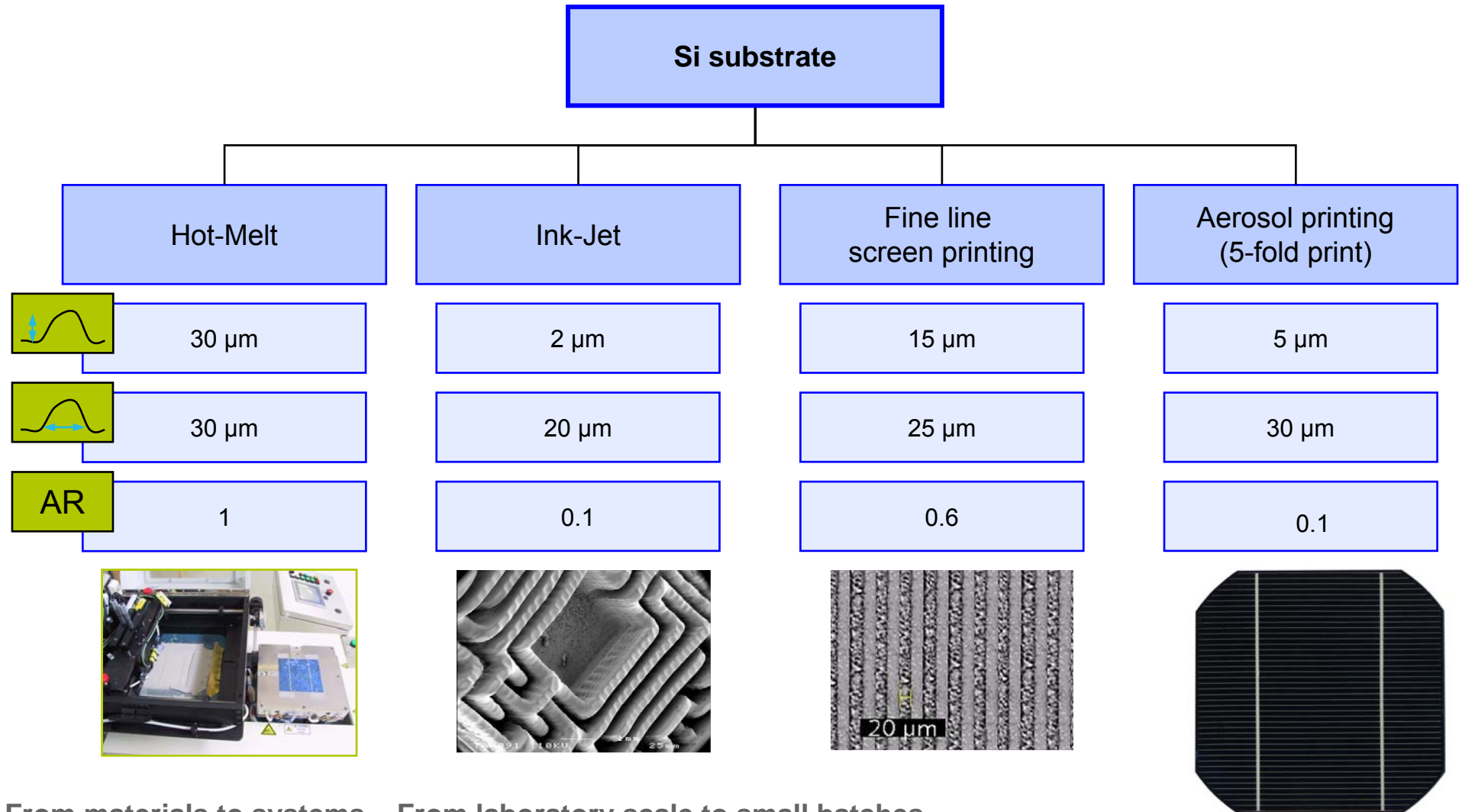


4 Lamination / co-firing



From materials to systems – From laboratory scale to small batches

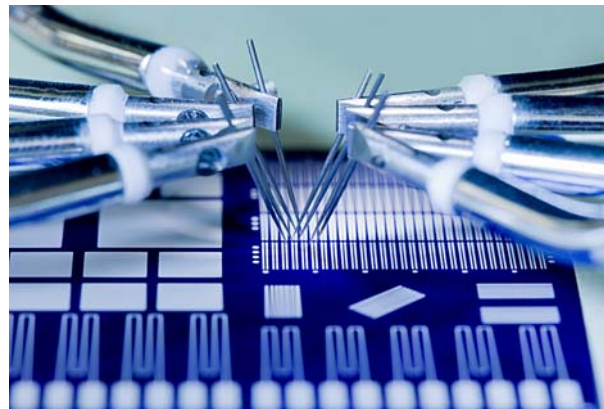
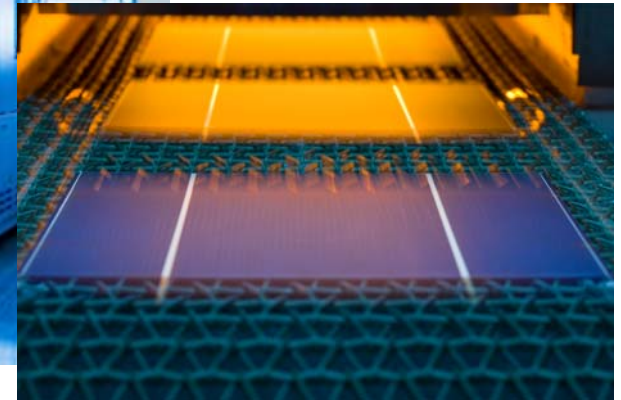
IKTS – Photovoltaics: Metallization



From materials to systems – From laboratory scale to small batches

IKTS – Photovoltaics: processing and characterization

- ▶ BTU firing furnace
- ▶ IR firing furnace continuous line
- ▶ Automated 2x4 point probe for resistivity measurements
- ▶ Solar simulator



IKTS – Material development – battery production

Powder – suspension - paste

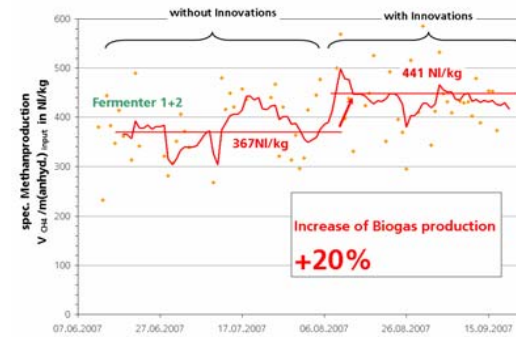
- ▶ Materials for Cathodes
Li-Mn-Co-Ni Oxides
- ▶ Development and production of pastes for anodes and cathodes
- ▶ Ceramic membrane materials
- ▶ → Functionality, stability, processing



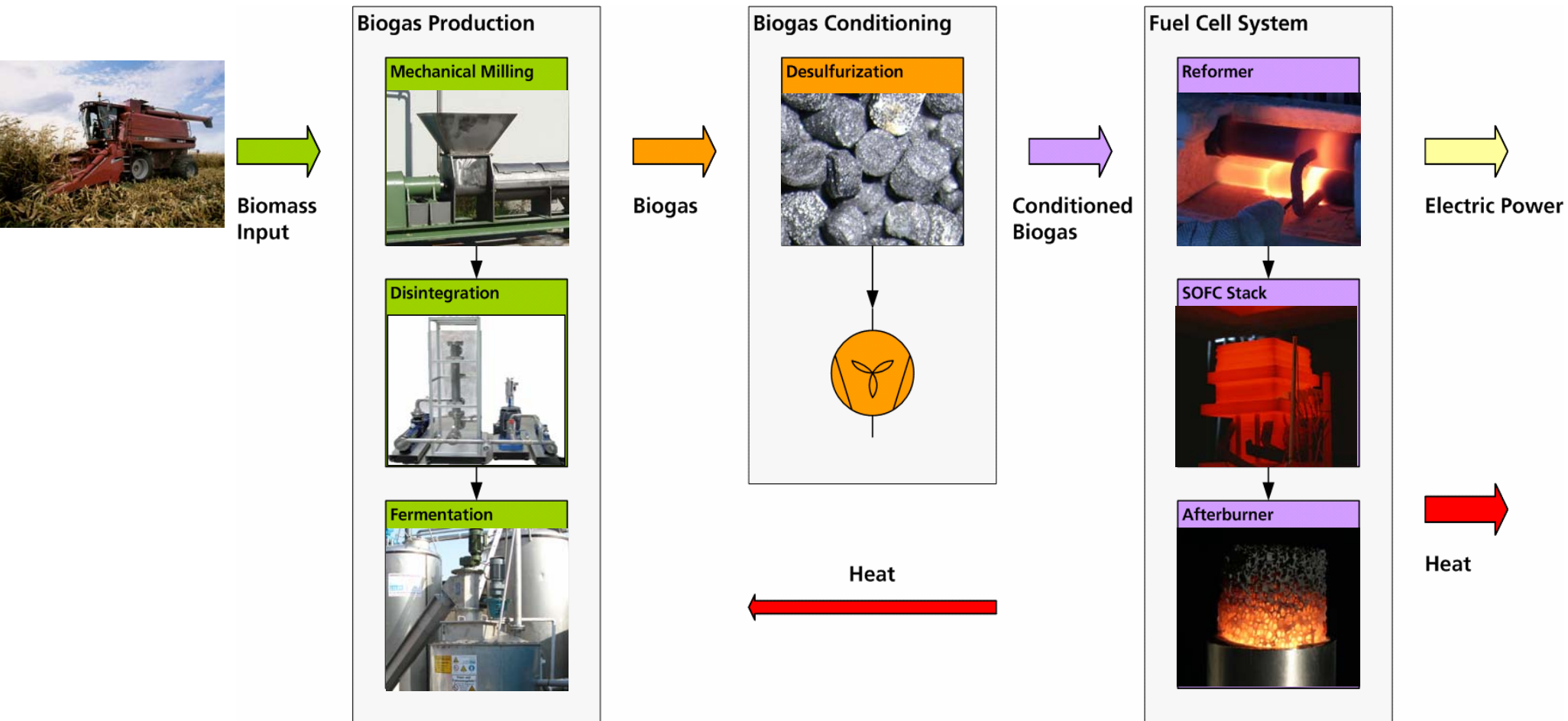
From materials to systems – From laboratory scale to small batches

IKTS – Renewable energy generation: biogas production

- ▶ Development of methods and systems for municipal and industrial wastewater treatment plants
- ▶ Successive utilization of organic substances for energy production by special educt treatments
- ▶ Fermentation of biogenous remnants (straw)
- ▶ Efficiency improvement of plants biogas



IKTS – Renewable energy generation: from biomass to heat and electrical power



IKTS – High-end characterization methods

- ▶ Powder characterization (PSD, BET, Zeta-Potential)
- ▶ XRD (Hot-Stage-XRD)
- ▶ Simultaneous thermal analysis (DTA/TG/MS)
- ▶ Impedance spectroscopy (in situ)
- ▶ Rheological characterization
- ▶ Chemical stability
- ▶ FTIR / Raman spectroscopy (in situ)
- ▶ FESEM coupled with EDX equipped with FIB
- ▶ Ultrasonic microscope
- ▶ Computed tomography
- ▶ Ellipsometry
- ▶ Reflectometry



Summary

Solarvalley e.V. business office Dresden: EESA and Fraunhofer IKTS



Renewable energy research projects at Fraunhofer IKTS

- ▶ Development of materials and processes for PV application
- ▶ System solution for efficient biogas production
- ▶ SOFC: from mW to kW application
- ▶ Development of small fuel cell systems (SOFC, PEM)
- ▶ Membrane and filter technology (Diesel particulate filter)
- ▶ TEG (Thermoelectric generators)
- ▶ „energy harvesting“ (Piezoceramics)
- ▶ Battery technology (Li-Ion)

