

**VANGUARD INITIATIVE**  
New growth through smart specialisation

# Workshop on Nano-Enabled Printed Electronics

Vanguard Pilot « New Nano-Enabled Products »

Sept. 13, 2016

<https://www.nanomat.de/PE-Workshop2016.php>

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# Scope

## Workshop Features:

- **Hear** about showcases from selected Vanguard regions
- **Participate** in the SME and pilot line registry
- **Engage** in discussions with experts from Europe's leading industry regions
- **Find** project partners and funding opportunities



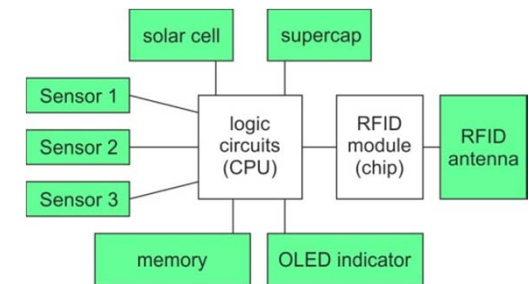
# Scope

## Two targeted areas of technology:

### 1. Cross-technology integration

(combining, e.g., printed energy harvesting, energy storage, sensors, displays, memory, passives)

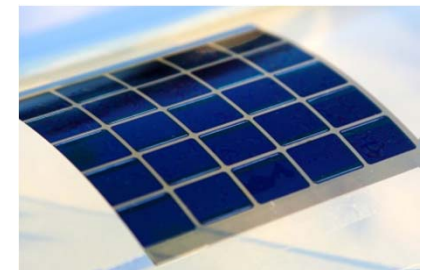
- Smart food monitoring
- Wearables (e.g., healthcare)
- Smart textiles (e.g., drapes, carpets, wallpapers)
- Smart energy



### 2. Printed, light-weight, flexible photovoltaics

(combining, e.g., large area printed energy harvesting, passives, added functionality such as switchable opacity)

- Construction and buildings (windows & façades, greenhouses)
- Automotive (curved surfaces)
- Consumer products



# Scope

## Regions involved or interested:

- Baden-Württemberg (BW)
- Brabant (BR)
- Emilia-Romagna (ER)
- East Netherlands (EN)
- Flanders (FL)
- Navarra (NA)
- Norte (NO)
- North Portugal (NP)
- Rhône-Alpes (RA)
- Skåne (SK)
- South Netherlands (SN)
- Tampere (TA)
- Wallonia (WA)



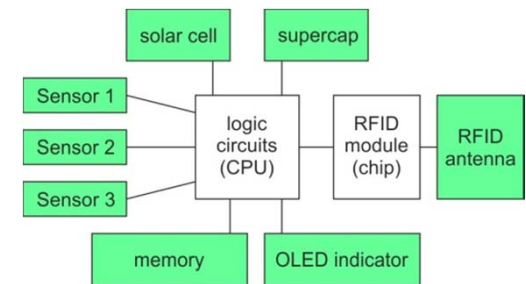
# 1. Cross-technology integration

Two targeted areas of technology:

## 1. Cross-technology integration

(combining, e.g., printed energy harvesting, energy storage, sensors, displays, memory, passives)

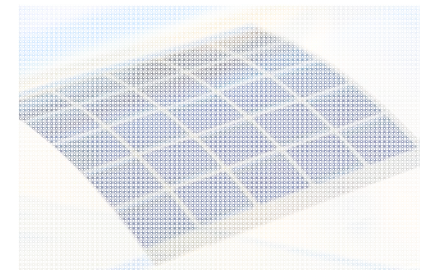
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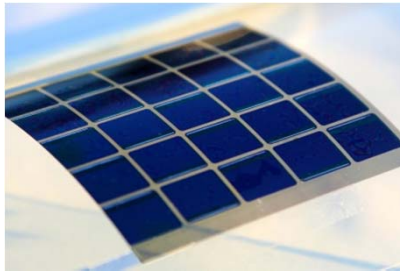
## 2. Printed, light-weight, flexible photovoltaics

(combining, e.g., large area printed energy harvesting, passives, added functionality such as switchable opacity)

- Construction and buildings (windows & façades, greenhouses)
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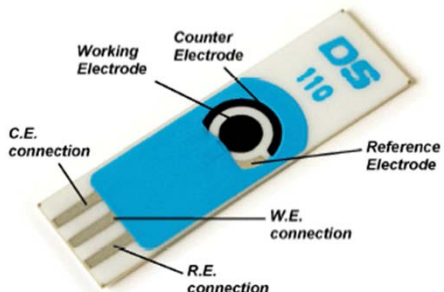
# 1. Cross-technology integration: Concept



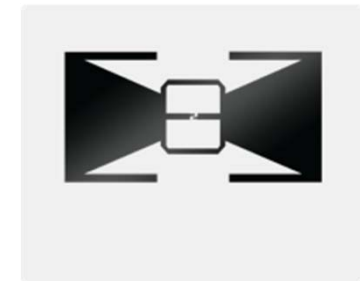
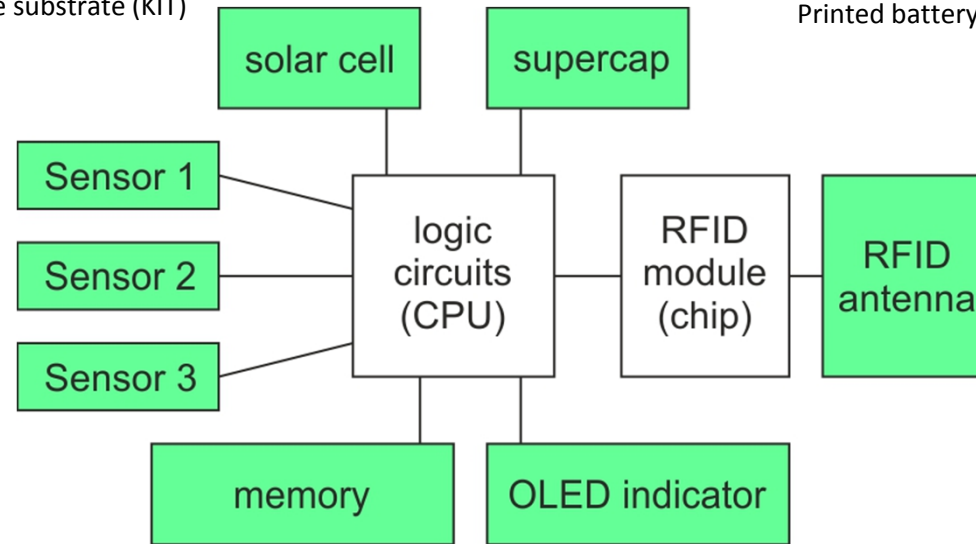
Printed organic solar sub-module on mechanically flexible substrate (KIT)



Printed battery (Enfucell)



Screen-printed electrodes for disposable devices (DropSens)



Hybrid passive RFID w/ screen printed antenna



Smart label w/ printed memory technology licensed to Xerox



Inkjet-printed OLED technology (in collaboration w/ Merck)

# 1. Cross-technology integration: Concept

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## Underlying technologies (pick 2 or more...):

- Printed energy harvesting
- Printed energy storage
- Printed sensors
- Printed OLEDs
- Printed memory (logic circuits?)
- Printed passives
- Hybrid technology

## Targets:

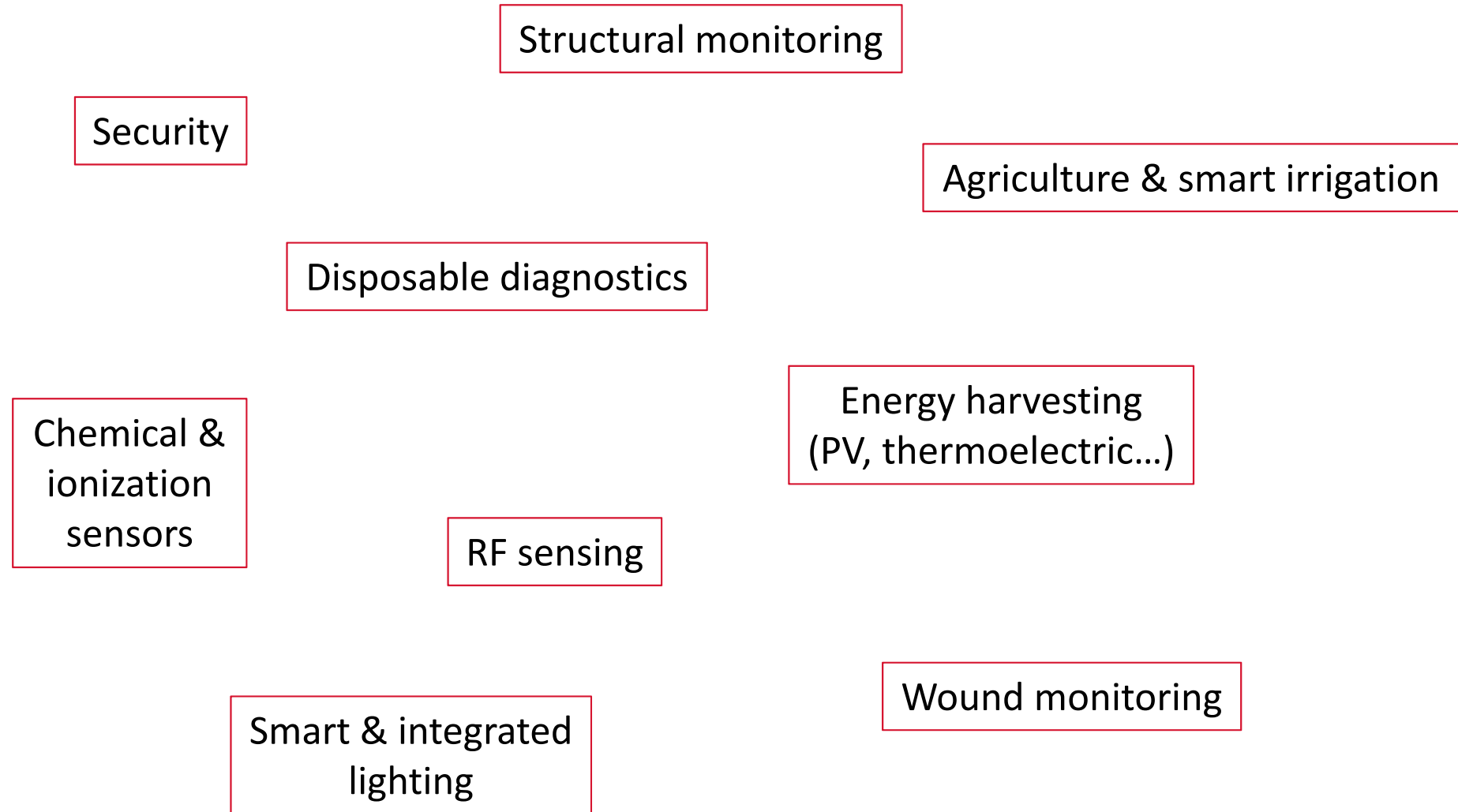
- Multi-functionality
- Plug-and-play architecture
- Easy fabrication (→ cost)
- Sustainable materials
- Platform technology character

## Boundary conditions:

- Nano-enabled
- Novel applications
- Complete value chain
- Added value of co-operation

# 1. Cross-technology integration: Potential applications

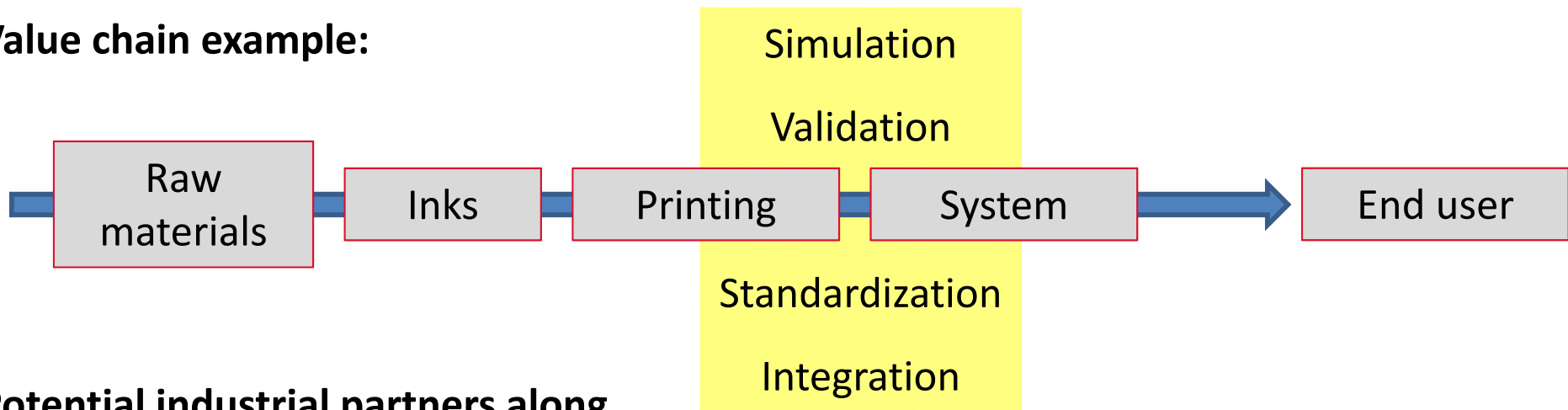
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# 1. Cross-technology integration

Value chain example:



Potential industrial partners along value chain (often covering several categories)

BASF (BW)  
 Binder Elektronik (BW)  
 Evonik (BW)  
 Iolitec (BW)  
 Merck (BW)  
 Felix Schoeller (BW)  
 Glatfelter (BW)  
 Appl. Nano Layers (EN)  
 Solmates (EN)  
 Solvay (FL)  
 Agfa (FL)  
 Novopolymers (FL)  
 AVL Metal Powder (FL)  
 Umicore (FL)  
 ChemStream (FL)  
 Tecnan (NA)

Cynora (BW)  
 GSB-Wahl (BW)  
 Balcaen (FL)

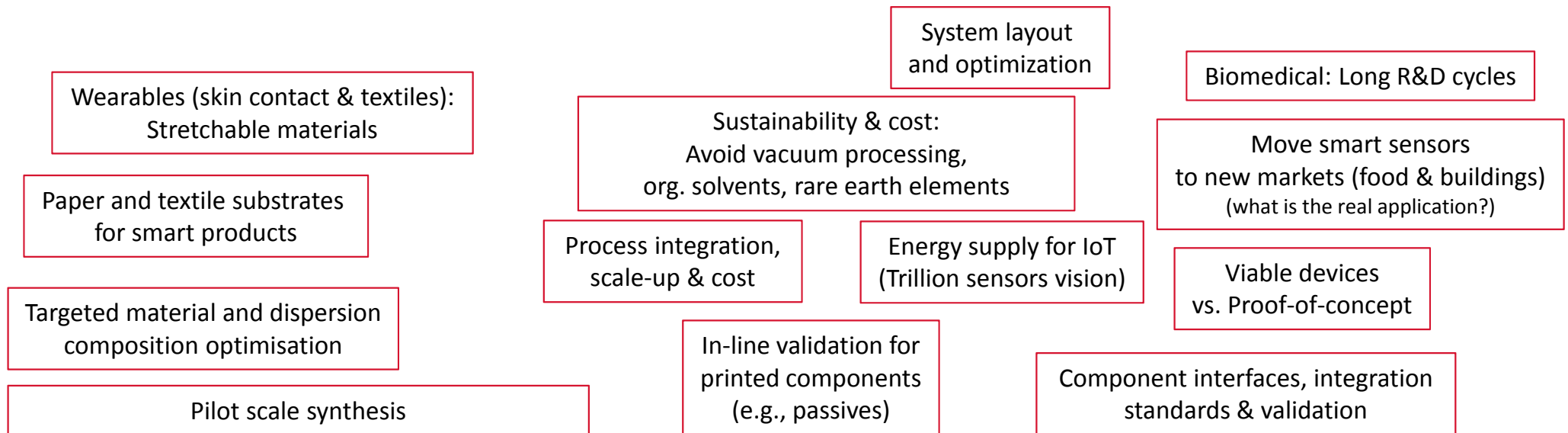
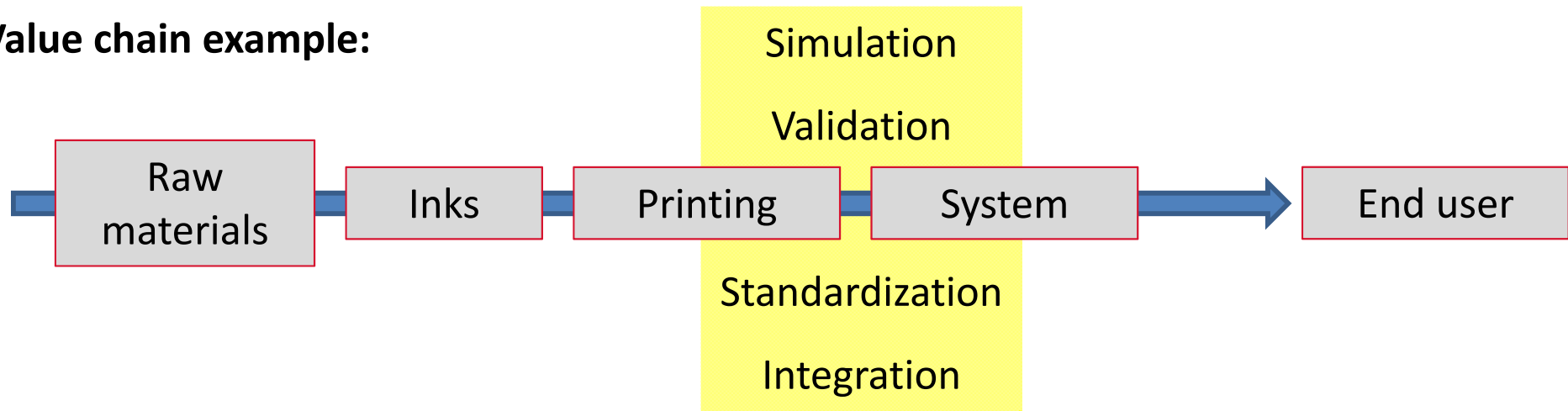
Innovationlab (BW)  
 Heidelberger Druck (BW)  
 HSG (BW)  
 Notion Systems (BW)  
 NXP (EN)  
 Flamac (FL)  
 IMEC (FL)  
 CEMITEC (NA)  
 ISC (NA)  
 VTT (TA)  
 CRM Group (WA)

BMO (BR)  
 Domicro (BR)  
 Metafas (BR)  
 TNO (BR)  
 Binder (BW)  
 Bosch (BW)  
 Varta (BW)  
 NedCard (EN)  
 NXP (EN)  
 CRIT (ER)  
 Quad Technologies (FL)  
 CartaMundi (FL)  
 VanGenechten (FL)  
 Biomensio (TA)  
 Confidex (TA)  
 Elcoflex (TA)  
 Flexbright (TA)  
 Goodwiller (TA)  
 Orion Diagnostica (TA)  
 Screentec (TA)  
 ToP Tunniste (TA)  
 Plastiwin (WA)

Etifix (BW)  
 Roche (BW)  
 APC-Duiven (EN)  
 Sencio (EN)  
 NedCard (EN)  
 TetraPak (SK)  
 Ouman (TA)  
 SSAB (TA)  
 Stora-Enso (TA)  
 Walki (TA)

# 1. Cross-technology integration: Challenges

Value chain example:



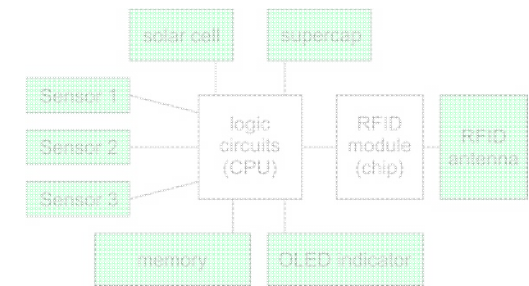
# 2. Printed, light-weight & flexible photovoltaics

## Two targeted areas of technology:

### 1. Cross-technology integration

(combining, e.g., printed energy harvesting, energy storage, sensors, displays, memory, passives)

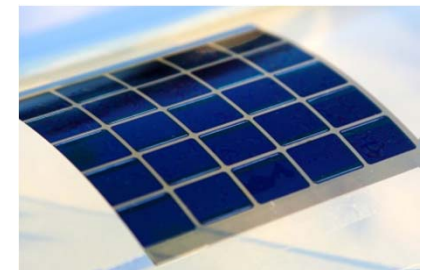
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### 2. Printed, light-weight, flexible photovoltaics

(combining, e.g., large area printed energy harvesting, passives, added functionality such as switchable opacity)

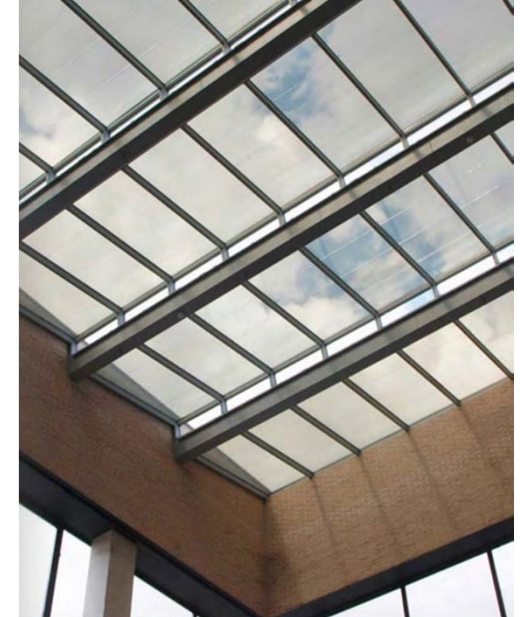
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- Automotive (curved surfaces)
- Consumer products



## 2. Printed, light-weight & flexible photovoltaics: Concept

A successful **demonstrator for integrated energy harvesting** in construction and buildings should comprise the following characteristics:

- Reasonable energy harvesting efficiency (10%, credible to achieve 15% in 10 years)
- Long service life (> 15 years, depending on system cost and performance)
- Low cost due to simple additive manufacturing process
- Simple, additive technology integration
- Sustainable materials
- Multi-functionality (energy harvesting, IR blocking, switchable opacity...)



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## 2. Printed, light-weight & flexible photovoltaics: Concept

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### Underlying technologies:

- Printed, large area energy harvesting
- Printed passives
- Added functionality

### Boundary conditions:

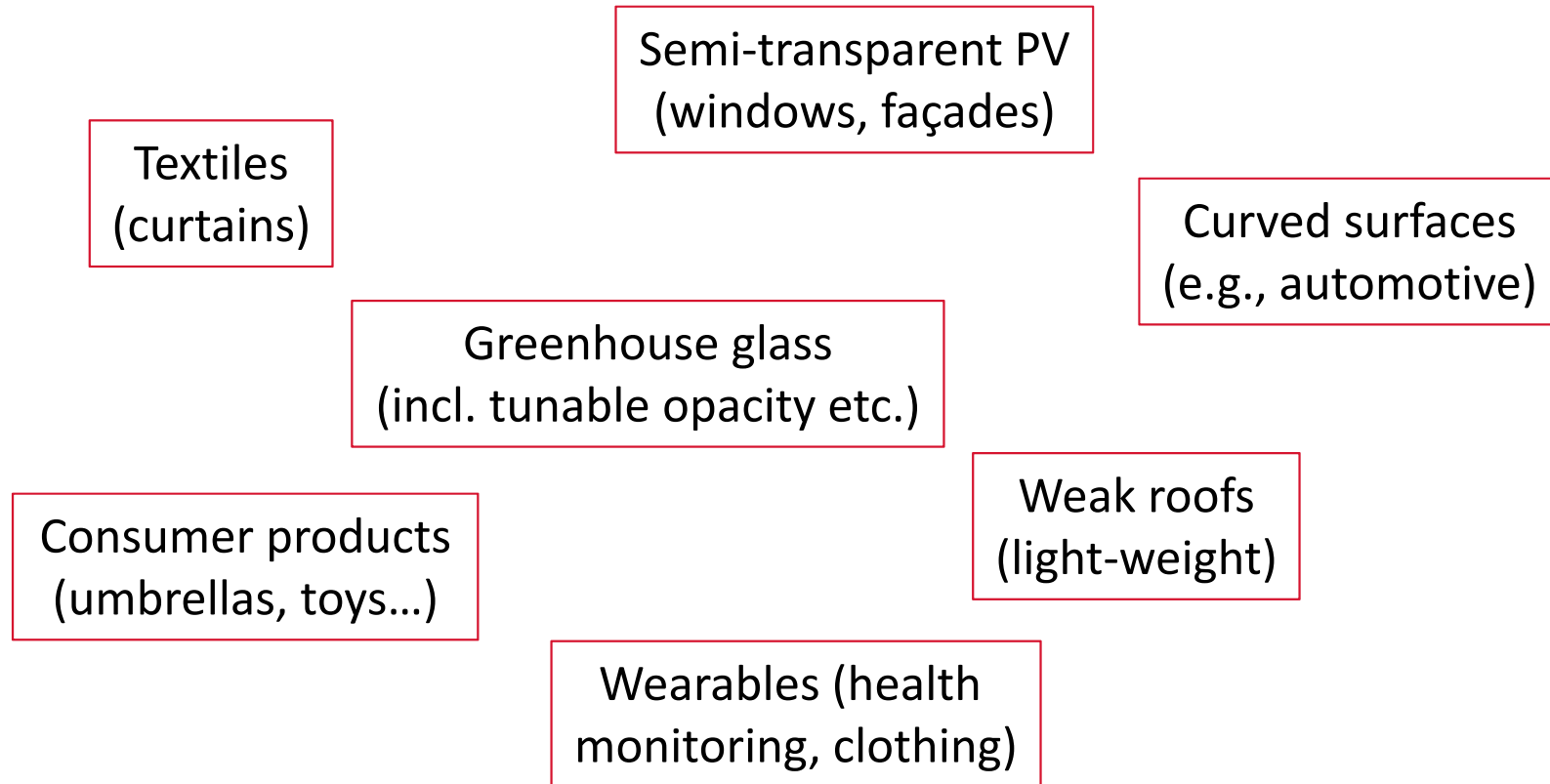
- Nano-enabled
- Printing-based
- Complete value chain
- Added value of co-operation

### Targets:

- Reasonable energy harvesting efficiency
- Long service life
- Low cost
- Simple, additive technology integration
- Sustainable materials
- Multi-functionality (IR blocking, switchable)

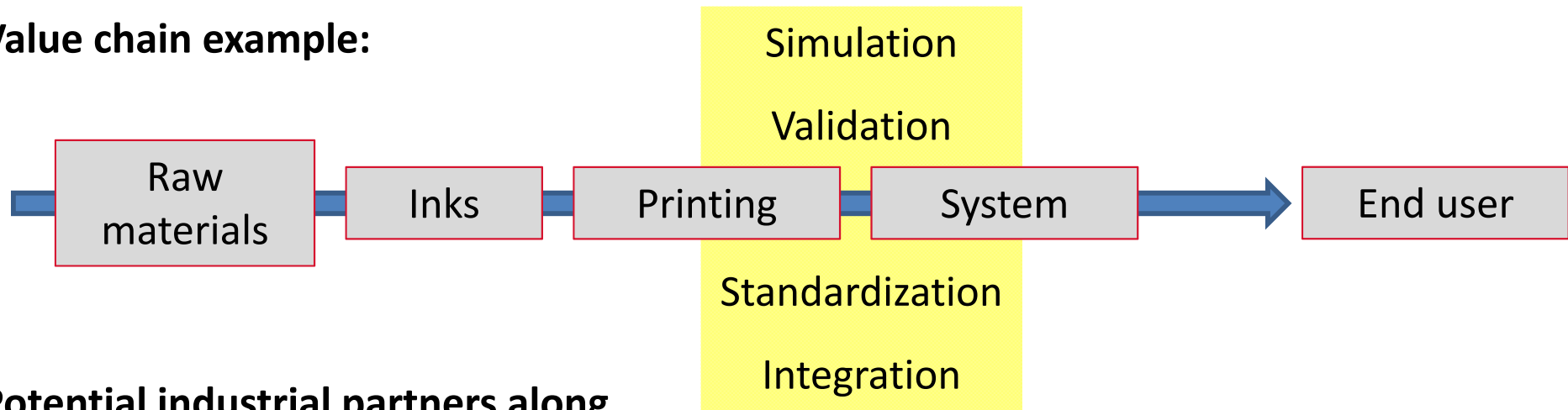
## 2. Printed, light-weight & flexible photovoltaics: Potential applications

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# 2. Printed, light-weight & flexible photovoltaics

Value chain example:



Potential industrial partners along value chain (often covering several categories)

BASF (BW)  
 Evonik (BW)  
 InnovationLab (BW)  
 Merck (BW)  
 Appl. Nano Layers (EN)  
 Solvay (FL)  
 Agfa (FL)  
 AVL Metal Powder (FL)  
 Umicore (FL)  
 ChemStream (FL)

GSB-Wahl (BW)  
 Balcaen (FL)

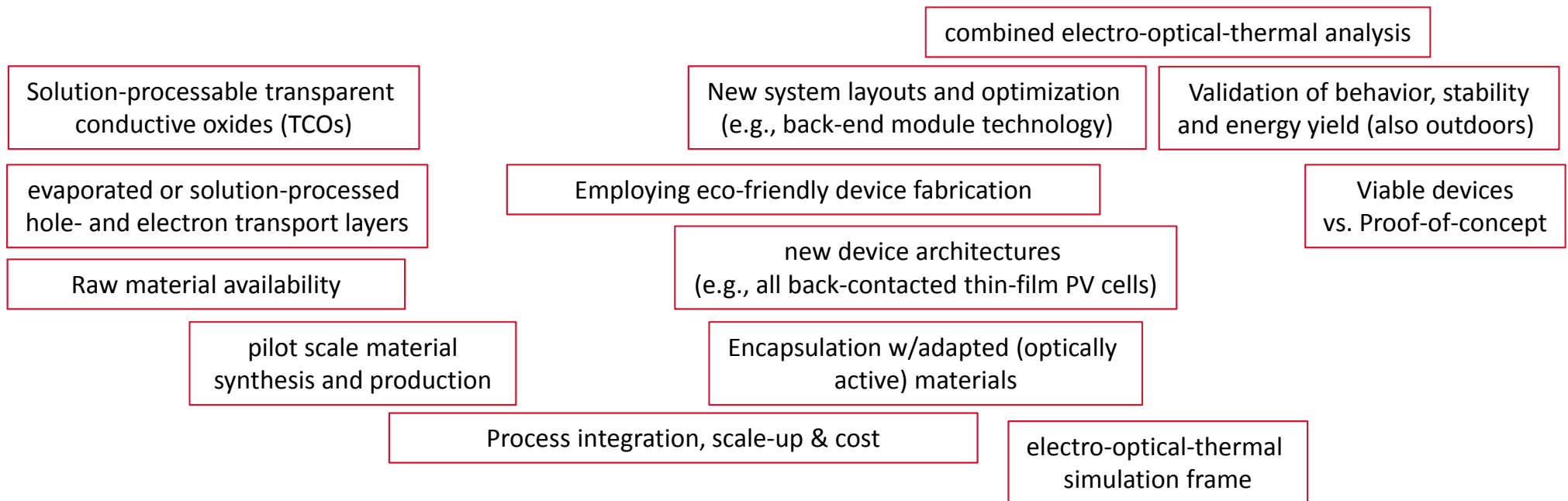
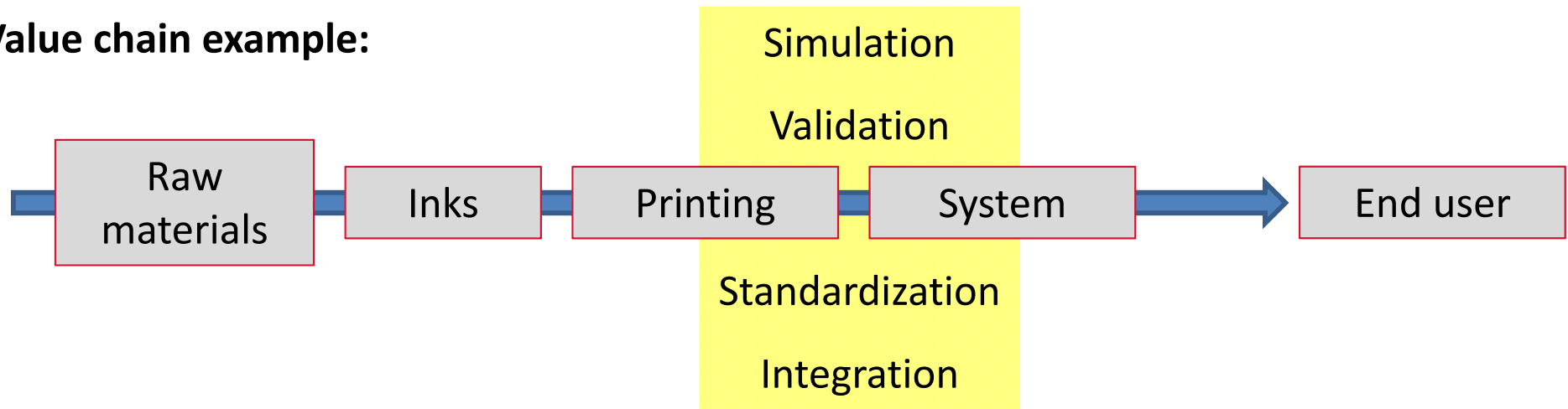
Innovationlab (BW)  
 Heidelberger Druck (BW)  
 Bystronic Glass (BW)  
 imec (FL)  
 FLAMAC (FL)  
 Materia Nova (WA)  
 Multitel (WA)  
 TWEED (WA)

Binder (BW)  
 Bosch (BW)  
 Würth Solar (BW)  
 CartaMundi (FL)  
 VanGenechten (FL)  
 CENER (NA)  
 Guardian Glass (NA)  
 TECNAN (NA)  
 Sol Voltaics (SK)  
 Hyet Solar (SN)  
 New Nordic Engineering (TA)

Daimler (BW)  
 TERRADISA (NA)

## 2. Printed, light-weight & flexible photovoltaics: Challenges

Value chain example:





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