Strategic Vision on European Research Infrastructure

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Context

EERA PV aims to help the European PV industry (research effort) with tasks including

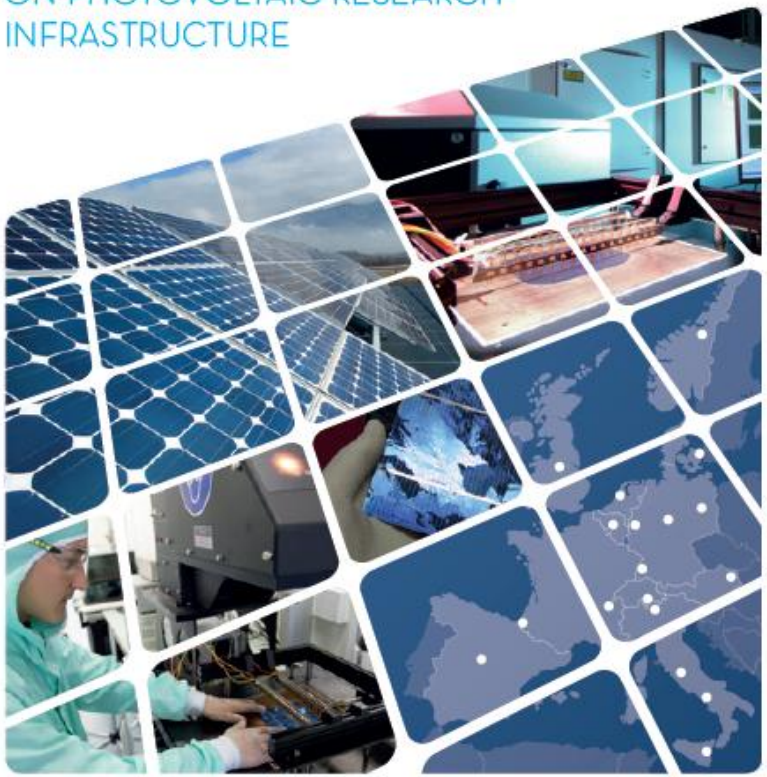
- Inventory of the research infrastructure (RI) available at the European R&D institutes
- Defining the future requirements for the R&D infrastructure in order to keep up to date with new PV developments.

Many members of EERA PV are in the FP7 SOPHIA project, which has resulted in the

Strategic Vision on Photovoltaic Research Infrastructures

Strategic vision

ON PHOTOVOLTAIC RESEARCH INFRASTRUCTURE



Purpose of Strategic Vison document

The **Strategic Vison document** presents the consensual view of 19 European research centres + EPIA, EUREC in SOPHIA consortium on the required RI for photovoltaic energy.

The **Strategic Vison document** :

- Describes current trends in the access and use of photovoltaic RI from the entire PV field: silicon materials, organic PV, thin films, concentrator PV, module lifetime, module and system performance and building integrated PV.
- Identifies the future RI needs of these PV technologies
- Aligned with SEII plan 2013-2015
- will serve as a proposal to ESFRI, the European Strategy Forum for Research Infrastructures

What is Research Infrastructure ?

In the context of SOPHIA:

1. ***a piece of experimental apparatus***
2. ***a cluster of different equipment, experimental procedures and expertise with a common objective needed to carry out an experiment.***

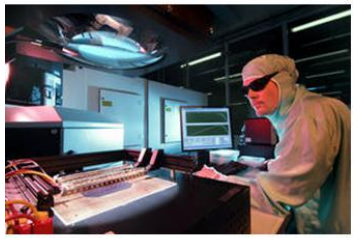
The complex in which it is housed is the 'research centre'

So we're talking hardware:

- Climate chamber for ALT
- Test rigs to simulate faults on the grid
- Synchrotron for probing the structure of materials
- A pilot line and the manufacturing equipment devices
- 1-2 MW plant with flexibility for testing different solutions to grid feed-in and the provision of ancillary services

Broader definitions of RI exist (@ EC) that include resources and services needed

Offering free access European PV RI



- Wafer cell imaging (ISE-IWES)
- Characterization facilities (ECN)
- Cell modelling Infra and software (imec)
- SUSI Platform (CEA-INES)
- Helios characterization (SINTEF)
- Helios Crystallization (SINTEF)
- Processing line for cSi solar cells (ENEA)

- UHV end station (HZB)
- EPR characterization (HZB)
- European Solar Test Installation (JRC)
- TCO sputter-depositon and characterization (HZB)
- Module laboratory (CEA-INES)
- TCO-sputter MOCVD deposition and characterization (ENEA)

- Permeameter for barrier characterization (CEA-INES)
- OPV processing facility (DTU, VTT)
- Advanced characterization platform (DTU)
- Thermal deposition of molecular materials (HZB)
- Characterization and accelerated test lab (Technalia)
- OPV-line (imec)

- Computing resources and modelling (Julich)
- Optical thermal and mechanical modeling of (BI)PV modules (Technalia)
- ENEA GRID (ENEA)

Si material | Thin films | OPV | Modelling

SOPHIA technical topics

Module lifetime | Module & system performance | CPV

- Performance and degradation modeling (ECN)
- Characterization of stress distribution in mini-modules (imec)
- Module characterization facility (CREST)

- PV test lab (ISE-IWES)
- Outdoor module test facility
- (ISE-IWES, ECN,CEA-INES, ENEL)
- PV Test facility (RSE)
- PV module qualification laboratory (ENEA)
- Combined indoor durability test facility (ISE-IWES, CEA-INES)
- PV module and system lab (AIT)
- BIPV test platform (CEA-INES)
- KUBIK (TECHNALIA)

- Indoor sun simulator for CPV (ISE-IWES)
- CPV test facility (RSE)
- MJ cells characterization: indoor sun simulator, EQE, Photoluminescence (RSE)
- Outdoor monitoring station (ISE-IWES, ENEL)
- Indoor/Outdoor characterization of CPV (UPM)
- Indoor/Outdoor CPV and lens characterization (ENEA)

Mapping European PV RI @ SOPHIA partners

Figure 4. The geographical spread of the SOPHIA research infrastructures located at the various SOPHIA partners

Strategic Vision discusses trends in PV RI

- Effects of manufacturing decline for research centres:
  - Potentially a downscaling of capacity to perform the highest quality research.

- Growth in demand for RI access is mainly for downstream work, in particular related to module performance assessment and system grid integration
  - Because cost/W_p becoming less important than cost/kWh
  - More aggressive ageing tests, testing beyond existing IEC
  - RCs are extending range of expertise (previously module + system performance; now also BIPV)

- Interest in unique single-site RI remains strong (i.e EPR, BESSY @ HZB, Berlin) or high performing supercomputing facilities (FZ Julich, Enea-Grid)
  - Slight drop in demand but still fully booked

BESSY

RI trends
Consolidation and growth strategies

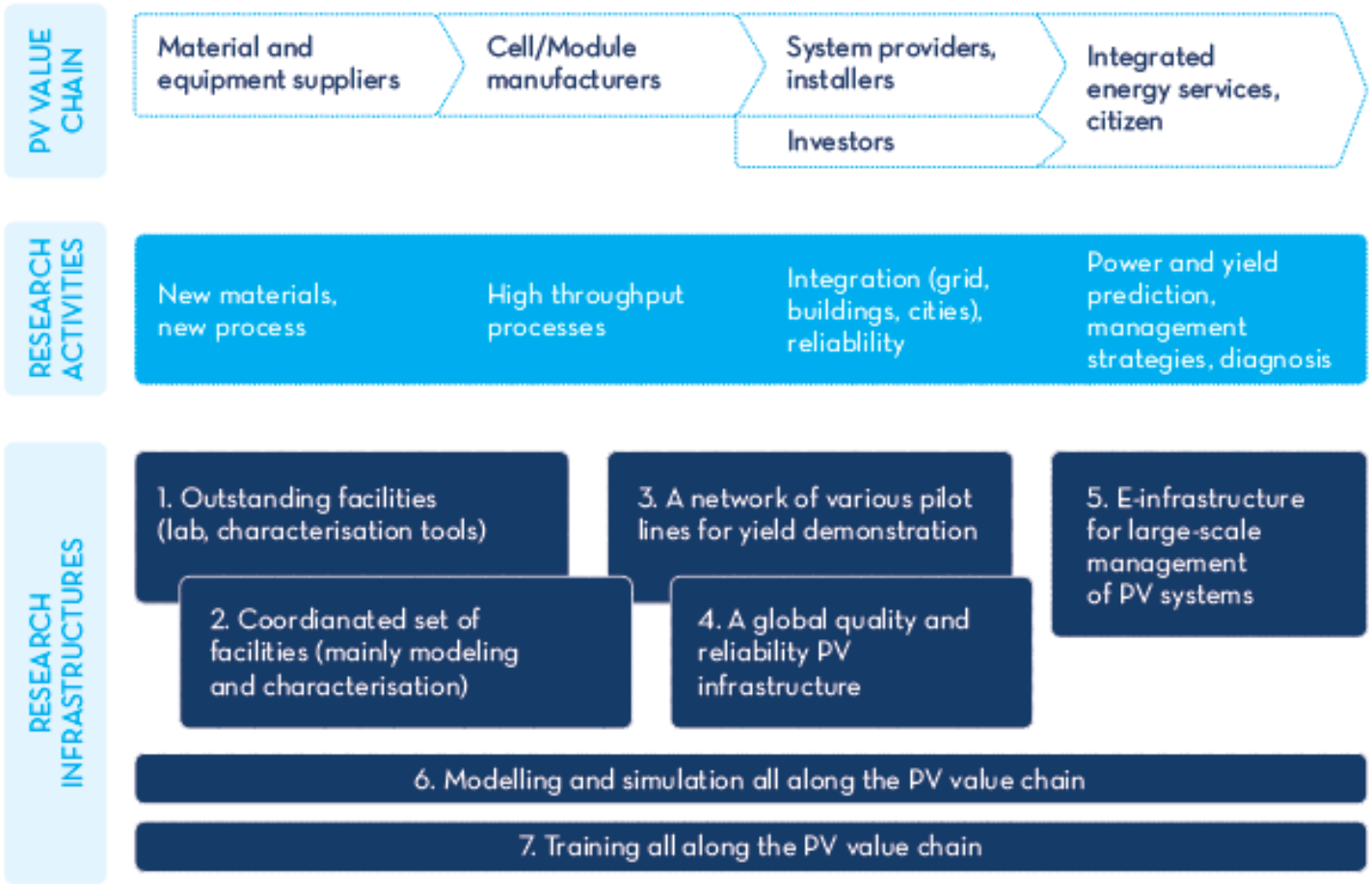
- Research centres have embraced a variety of consolidation and growth strategies

:

- **go niche**
  - Market RI for unique market applications
- **go extensive**
  - Complete lines in silicon technologies
- **go international**
  - Increase visibility of your RC overseas (China: collaborate on testing/certification)
- **be complementary**
  - Don’t do what the guy next to you is doing. EERA PV (Cheetah project) helping to avoid unintended duplication
- **get exposure to other industries**
  - RI apparatus has multiple use
- **market yourself as a cost-saving option**
  - ‘Affiliates programmes’: companies club together to fund research and share results
- **go application-driven**
  - ‘demo buildings and test roofs in BIPV – bringing the technology closer to its end-environment

Future RI needs all along the PV value chain

SEVEN TYPES OF RESEARCH INFRASTRUCTURES, ALL ALONG THE PV VALUE CHAIN

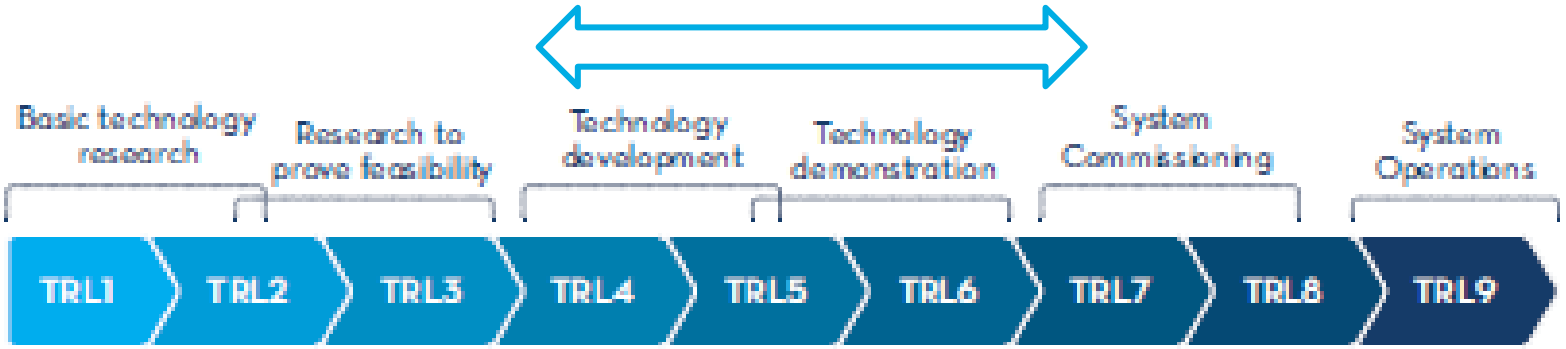


Inventory made by SOPHIA experts

Recommended RI for modules, systems and general	Technologies
Solar simulators for special conditions (low intensity, temperature)	All
Large area (10 m^2) continuous sun simulator	CPV, BIPV, thin films
Tools for preconditioning (temperature, spectrum, intensity)	Thin films, OPV
Flash light sun simulator with long pulses	Thin films, OPV, advanced Si concepts
Sun simulators with tunable spectrum for "power matching"	Thin film tandems
Advanced analytic &imaging methods for module failure analysis	All
Climate chambers for multiple stress testing (DH+UV/VIS)	All
Sites for field testing of grid-connected PV systems	All
Smart home systems	All
BIPV test façade racks	All, BIPV
Development of test protocols (beyond IEC), standards	All
Modelling tools for performance assessment (electrical, thermal), simulation of degradation behavior	All
Performance databases (e-infrastructures)	All

Large scale manufacturing lines and consequences for PV RI

Pilot-lines are used to test the efficiency and cost of major processing steps for different PV technologies (in line with SEII plan)



Develop consensus for future actions in Europe regarding PV pilot lines

- review existing and coordinated initiatives in other fields such as micro-electronics and nano-manufacturing
- review individual initiatives within the PV sector (bilateral Industry/RC, public-private partnerships, public…..)

Outlook: Recommendations (1/3)

Technological

- **Continuation of public access** to outstanding and unique equipment for characterisation and analysis as well as larger facilities for supercomputing.

- Continued **actions to coordinate and stimulate** exchange and use of RI dedicated to accelerated lifetime testing and lifetime predictions

.

- In-depth focus is required on **specific research topics such as quality assurance, reliability and standardisation**

- The **establishment of a number of pilot production lines**

Outlook: Recommendations (2/3)

Organizational

- Development of a **validation platform**, and **associated ratings** (e.g. AAA, AA etc) for **PV simulation t**ools
- **Concentration or clustering of RI platforms** necessary via the **formation of alliances** in strong regions
- **EC regulations** should be simplified to minimise the barriers for access to open R&D platforms.

Education

- RI should assure **access to researchers at all career levels.**

Outlook: Recommendations (3/3)

E- infrastructure

Development necessary because…

- Projects are increasingly being carried out at different sites near to or far from each other, and should be linked by **ICT solutions**
- Access **to large data collections** is of increasing importance
- **Sophisticated modelling or simulation software** available at the sites of different partners can be shared
- It has a **dissemination role**, enabling, through webinars easy direct contact between researchers and audiences of different technical familiarity with PV technology