Österreichische Photovoltaik Fachtagung

The French PV Market, Focus on BIPV and environmental impacts

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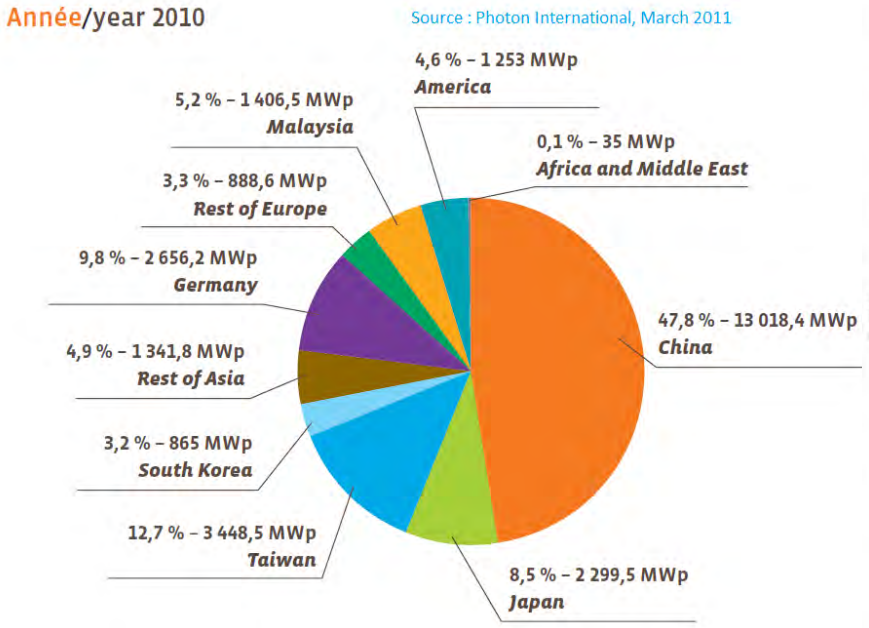
Summary

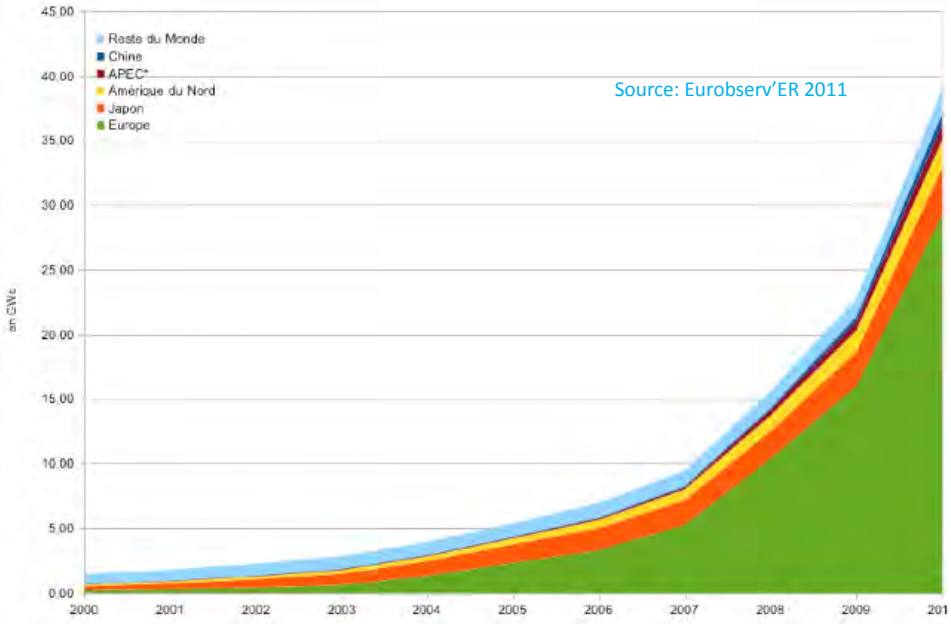
- **French PV market**
  - ✓ *Characteristics and evolution*
- **French FITs for grid-tied PV**
  - ✓ *Orientations and evolution*
  - ✓ *BIPV (Bulding Integrated PV)*
- **Examples of BIPV solutions**
  - ✓ *According to the French legal definition*
- **Environmental impacts of PV systems**
  - ✓ *Critical environmental parameters*
  - ✓ *Some results of Life Cycle Analysis (LCA) for BIPV systems*

French PV market – *Characteristics and evolution (1/4)*

- A quick look at the global market: PV production and installation



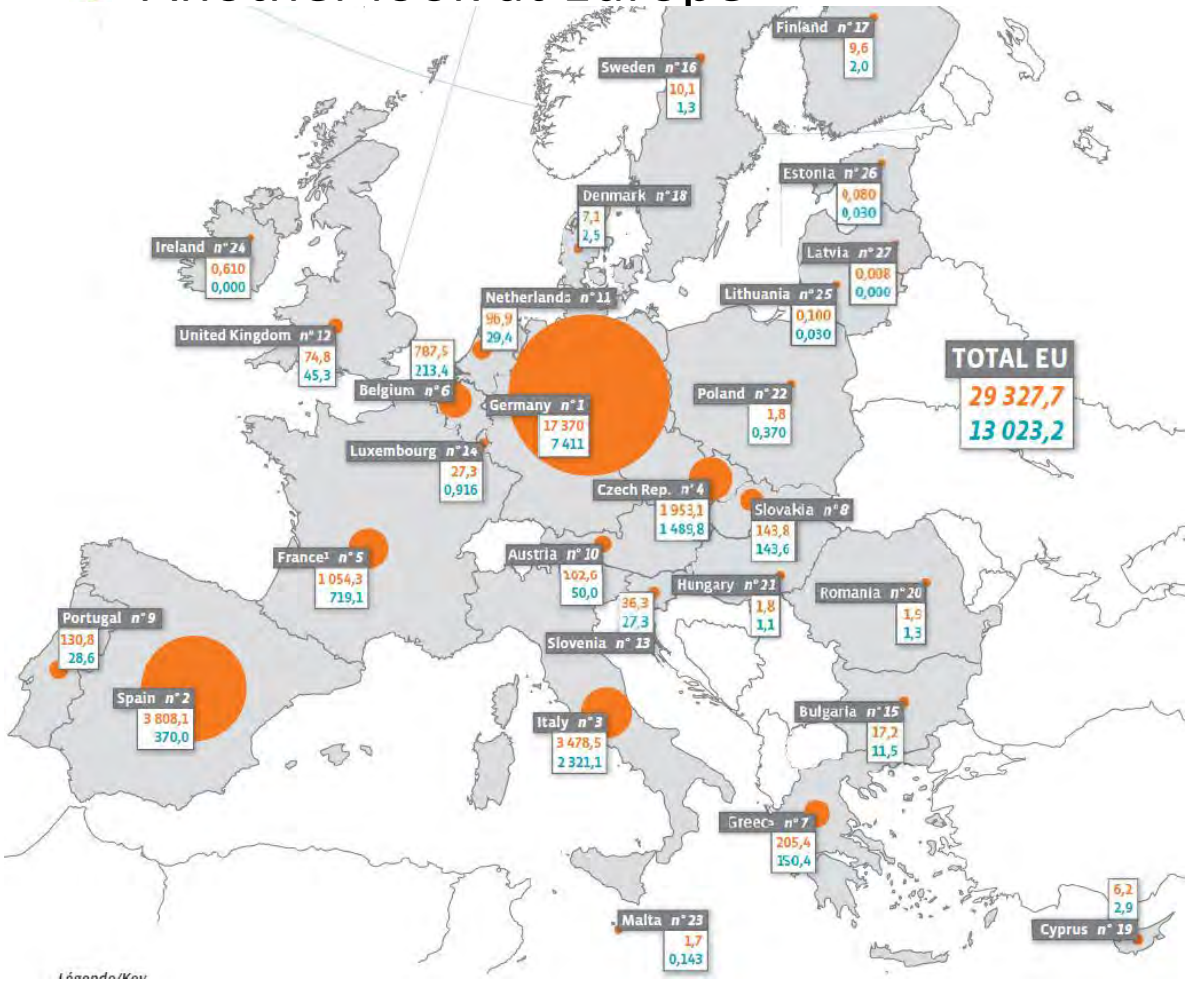
PV cells production around the world



PV installed capacity around the world (GWp)

French PV market – *Characteristics and evolution (2/4)*

- Another look at Europe



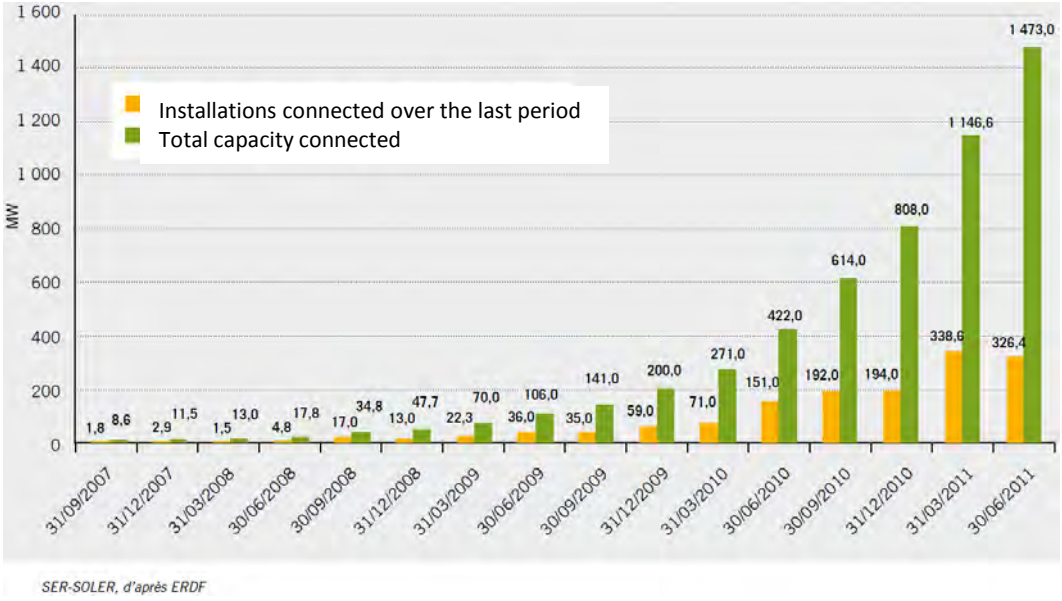
PV installed capacity around Europe

Total capacity installed in dec. 2010
Capacity installed during 2010

French PV market – *Characteristics and evolution (3/4)*

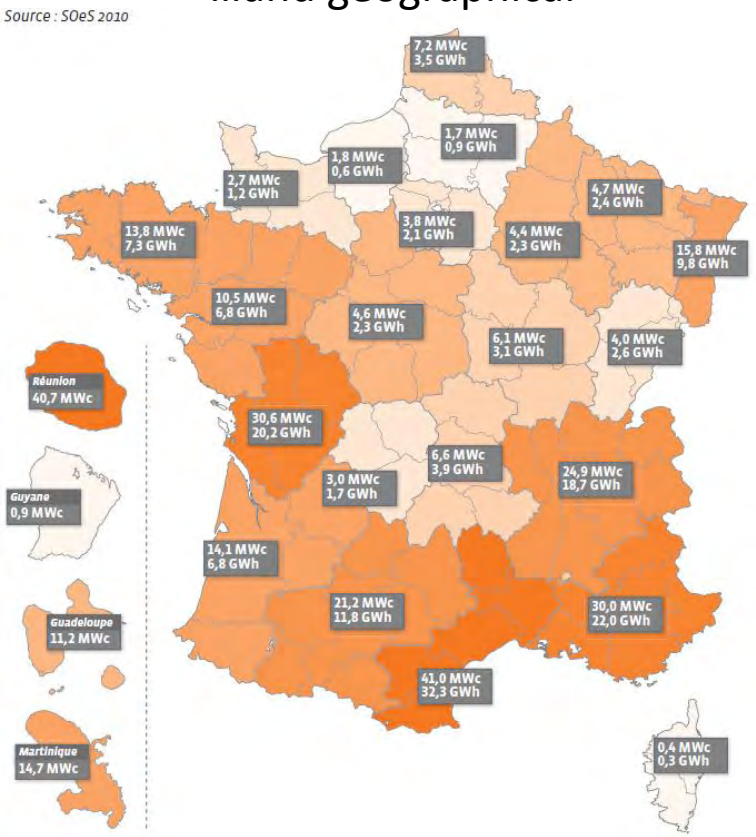
- A focus on France:

''Historical''…



Progression of the installed PV capacity in France

…and geographical



Distribution of PV installed capacity and production among French regions (03/30/2011)

French PV market – *Characteristics and evolution (4/4)*

- Explanation on the characteristics of this progression:

''Historical''…

✓ **Competitive FITs (feed-in tariffs), since July 2006 (until Dec. 2010)**

In continental France:

- **0,30€/kWh for any PV installation**
- **+ 0,25€/kWh bonus for BIPV**

In overseas departments:

- **0,40€/kWh for any PV installation**
- **+ 0,15€/kWh bonus for BIPV**

✓ Tariffs yearly revised according to national indexes for the cost of work and of industrial production

…and geographical

DÉPARTEMENT	RÉGION	COEFFICIENT R
Gard	Languedoc-Roussillon	1
Hérault	Languedoc-Roussillon	1
Alpes-de-Haute-Provence	Provence-Alpes-Côte d'Azur	1
Hautes-Alpes	Provence-Alpes-Côte d'Azur	1
Alpes-Maritimes	Provence-Alpes-Côte d'Azur	1
Bouches-du-Rhône	Provence-Alpes-Côte d'Azur	1
Var	Provence-Alpes-Côte d'Azur	1
Vaucluse	Provence-Alpes-Côte d'Azur	1
Drôme	Rhône-Alpes	1,01
Aveyron	Midi-Pyrénées	1,02
Aude	Languedoc-Roussillon	1,03
Pyrénées-Orientales	Languedoc-Roussillon	1,03
Tarn	Midi-Pyrénées	1,03
Tarn-et-Garonne	Midi-Pyrénées	1,03
Ardèche	Rhône-Alpes	1,03
Lot-et-Garonne	Aquitaine	1,04
Gers	Midi-Pyrénées	1,04
Gironde	Aquitaine	1,05
Lozère	Languedoc-Roussillon	1,05
Ariège	Midi-Pyrénées	1,05
Haute-Garonne	Midi-Pyrénées	1,05
Lot	Midi-Pyrénées	1,05
Charente-Maritime	Poitou-Charentes	1,05
Dordogne	Aquitaine	1,06
Landes	Aquitaine	1,06
Indre	Centre	1,06

Regional factors for FITs in France (14/01/2010)

French FITs for grid-tied PV – *Orientations and evolution (1/10)*

- A strong financial incentive towards BIPV
- Legal definition of BIPV in 2006:
  - ✓ « *… when the equipments for the production of PV power also provide a technical or architectural function that is essential to the act of construction. These equipments must belong to the exhaustive following list:*
    - *roofs, slates or tiles industrially designed with or without mounting;*
    - *sunshades (awnings);*
    - *window sills;*
    - *glass roofs without rear protection;*
    - *window, balcony or terrace balustrade;*
    - *cladding, curtain wall. »*

French FITs for grid-tied PV – *Orientations and evolution (2/10)*

Why BIPV ?

- ✓ Because PV is good for the environment!
- ✓ **Positive impact on the electric network** (closer to consumers)
- ✓ **Creation of local industry and employment**
- ✓ **No competition with agricultural lands**
- ✓ **Differentiation** with simplified BIPV or superimposed on **architectural and esthetic points of view**: a strength for export on an otherwise highly competitive PV market

Category	Residential BIPV	Non residential BIPV	Simplified BIPV	Ground-mounted PV
Impact on electricity taxes (CSPE, in €/MWh produced)	-	-	+	++
Cost of CO2 emissions saved (€/tCO2 saved)	-	-	+	++
Impact on the electric network	++	++	+	-
Value added and national employment	++	++	+	-
Leverage for export	++	++	+	+
	BIPV differentiation	BIPV differentiation	Least BIPV differentiation	Building of "national champions" (trackers?)

Relative relevance of different categories with regards to the objectives aimed by the public support to the PV field (Charpin-Trink parliamentary report, 17/02/2011)

French FITs for grid-tied PV – *Orientations and evolution (3/10)*

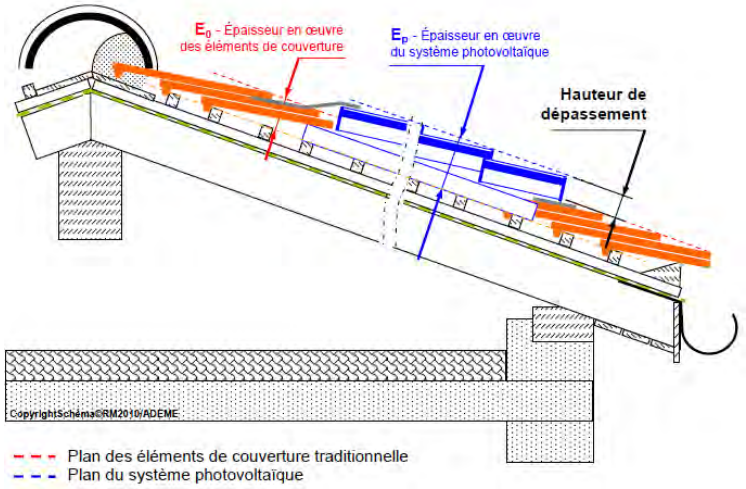
- A (very) large definition of BIPV that led to (some) « abuses »… or great projects ?
  - ✓ No size limitation
  - ✓ No restriction on the type or nature of the building

Photovoltaic warehouse

Marché Saint Charles (Perpignan, Aude) – 8.8 MWp BIPV installation

French FITs for grid-tied PV – *Orientations and evolution (4/10)*

- New definition for BIPV (January 12, 2010), new eligibility criteria:
  - ✓ Building closed and covered (on all lateral faces)
  - ✓ PV system installed on a roof that provides protection to persons, animals, assets or activities
  - ✓ Size of installation ≤250 kWp
  - ✓ PV system installed in the plane of the roof
  - ✓ PV system replaces elements of the building that provide the « closed and covered » and provide the function of watertightness
  - ✓ Removal of a module or film cannot be done without damage to the function of watertightness provided by the PV system or making the building improper for its use
  - ✓ For rigid modules: must be the main element for the watertighness of the system
  - ✓ For flexible films: assembling is done at plant or on site. If on site, it must be the object of a unique works contract
  - ✓ Distance between modules plane and roof plane : ≤ 60mm before 01/01/2012
    ≤20mm after 01/01/2012



French FITs for grid-tied PV – *Orientations and evolution (5/10)*

- The definition of a « **simplified BIPV** »:
  - ✓ PV system installed on a roof that provides protection to persons, animals, assets or activities
  - ✓ PV system installed parallel to the plane of the roof (without distance restriction between module and roof)
  - ✓ PV system replaces elements of the building that provide the « closed and covered » and provide the function of watertightness
  - ✓ **Removal of a module or film do not damage to the function of watertightness provided by the PV system**

French FITs for grid-tied PV – *Orientations and evolution (6/10)*

Creation of a BIPV Products Assessment Committee (CEIAB)

- ✓ Presided by the French Department of Energy and Climate, managed by the ADEME (Energy Management and Environment Agency) and CSTB (Scientific and Technical Center for Construction)
- ✓ In charge of reviewing the products submitted to characterize products between « BIPV », « simplified BIPV », or « non BIPV » (www.ceiab-pv.fr)
- ✓ Indicative database for PV project developers

14/09/2011 – LISTE NON EXHAUSTIVE CEIAB pour IAB toiture – Version 0.5 2/14

Liste des systèmes photovoltaïques examinés par le CEIAB et répondant aux critères techniques d'**Intégration Au Bâti (IAB) en toiture** de l'arrêté tarifaire du 4 Mars 2011

Dénomination commerciale	Société demandeur	Référence CEIAB	Principe du système	Photo mise en œuvre	Couverture Totale	Eligibilité	Couverture Partielle							
							Ardoises	Tuiles plates	Tuiles à pureau plat emboîtement	Tuiles à relief emboîtement	Tuiles "Canal"	Plaques profilées fibres-ciment	Plaques "imitation ardoises" en acier	REMARQUES DU COMITE
SIPV UNIVERSEL	ABCD INTERNATIONAL	0157-P			IAB	2011	IAB	IAB	IAB	IAB	IAB	IAB	IAB	Sous réserve de mettre en œuvre un abergement en rive de tôle de type « besace » (ou bavette)
						2012			IAB	IAB	IAB			
ALEO SOLRIF	ALEO SOLAR	0079-P				2011			IAB	IAB	IAB			
						2012			IAB	IAB	IAB			
AUVERS' TYLE	AUVERSUN	0072-P				2011		IAB	IAB	IAB	IAB			
						2012				IAB	IAB			
SOL25I	AIXIA	0045-P				2011			IAB	IAB	IAB			
						2012			IAB	IAB	IAB			
FAG	CAPTELIA	0014-P				2011			IAB					
						2012			IAB					

Dans la liste ci-dessus et selon les hypothèses d'épaisseur moyenne en œuvre des éléments de couverture retenues par le CEIAB, est indiqué à titre indicatif :
- en rouge avec la mention IAB, le domaine d'emploi où le système répond aux exigences techniques prévues par l'arrêté du 4 Mars 2011 ;
- en jaune sans la mention IAB, le domaine d'emploi où le système répond à l'ensemble des exigences techniques à l'exception de la hauteur maximale de dépassement.

L'ADEME recommande au porteur de projet l'installation de systèmes photovoltaïques sous AVIS TECHNIQUE, voire PASS'INNOVATION « VERT » qui apportent la preuve de l'aptitude à l'emploi et de la durabilité du procédé photovoltaïque (stabilité, étanchéité, sécurité etc.) - listes des procédés évalués sur www.photovoltaique.info ou www.ssfv.fr

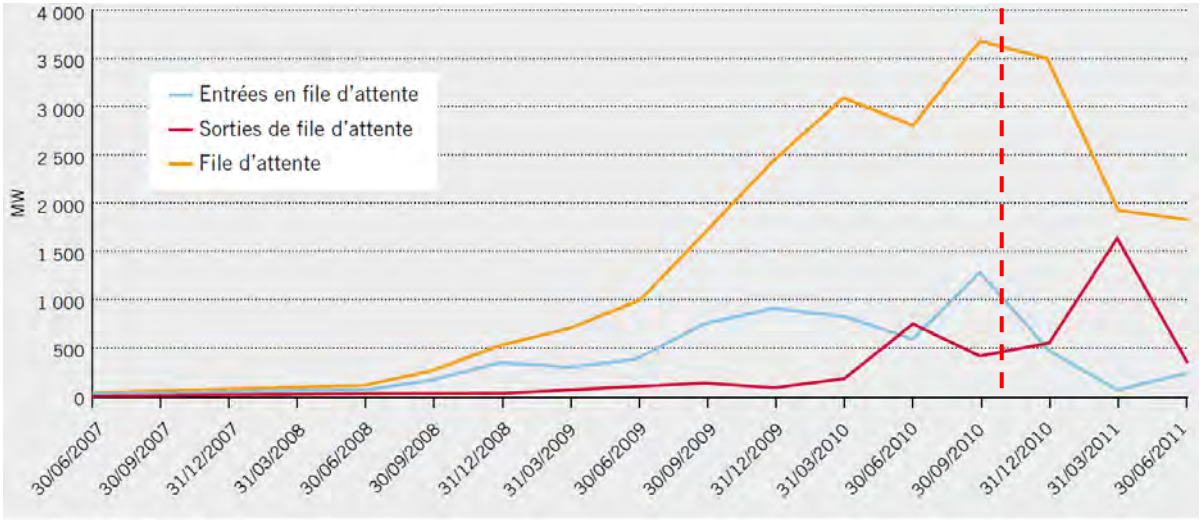
French FITs for grid-tied PV – *Orientations and evolution (7/10)*

- December 2010 – March 2011: a serious blow to the PV field in France
  - ✓ **Moratorium on all PV projects on-going grid connection requests**
  - ✓ Main reason:
    - ✓ Too many projects! Waiting list higher than French Gov. target for 2020 (5,4 GWp)
  - ✓ Objectives:
    - ➢ Define a new « balance » for FIT to halt the creation of a « PV bubble »
    - ➢ Take the necessary time to concert all the interested parties
    - ➢ Find a balance between ecological determination and protection of consumers who would have undergone a rise of elecricity prices

French FITs for grid-tied PV – *Orientations and evolution (8/10)*

- The outcomes of a harsh period (the « PV moratorium »)
  - ✓ New, lower FITs
  - ✓ **FITs granted up to 100 kWp systems and for BIPV only**
  - ✓ New procedures for projects **over 100 kWp: open tendering**, with economic, innovation and environmental criteria (LCA), and with limitation of the yearly installed capacity:
    - ✓ For system between 100-250kWp : 30 MWp every 3 months
    - ✓ For PV system >250kWp : 180 MWp per year
  - ✓ ➔ A sudden drop of connection requests…

PV moratorium



Source : SER-SOLER, d'après ERDF)

French FITs for grid-tied PV – *Orientations and evolution (9/10)*

- Evolution of the FITs (projects below 100 kWp):
  - ✓ New definition of types of buildings
  - ✓ Size of installation

FIT before moratorium

Any type of installation	**0,30 €/kWh**
BIPV	**0,55 €/kWh**

FIT after moratorium (March 2011)

Type of building		**Power range**	**FIT between 07/01/2011 and 09/30/2011**
Residential	BIPV	0-9 kWp	0,4255 €/kWh
		9-36 kWp	0,3723 €/kWh
	Simplified BIPV	0-36 kWp	0,2746 €/kWh
		36-100 kWp	0,2609 €/kWh
Buildings dedicated to health or education	BIPV	0-9 kWp	0,3674 €/kWh
		9-36 kWp	0,3674 €/kWh
	Simplified BIPV	0-36 kWp	0,2746 €/kWh
		36-100 kWp	0,2609 €/kWh
Other types of buildings	BIPV	0-9 kWp	0,3185 €/kWh
	Simplified BIPV	0-36 kWp	0,2746 €/kWh
		36-100 kWp	0,2609 €/kWh
Any other type of installation		**0-12 MWp**	**0,11688 €/kWh**

  - ✓ BIPV foreseen as the main market in France for the coming years
  - ✓ FITs are revalued every trimester according to the amount (in total peak power) of projects registered during the previous term (revaluation only on decline), with the NREAP objective as upper limit (5 400 MWp in 2020)

French FITs for grid-tie PV – *Orientations and evolution (10/10)*

- **Creation of a label: AQPV (PV Quality Alliance)**
  - ✓ Collective mark created on 07/20/2011 by the French Ministries of Environment and of Industry

ALLIANCE QUALITÉ PHOTOVOLTAÏQUE

  - ✓ **2 labels: « module assembled in France »** and **« semi-conductor made in France »**
  - ✓ Objective:
    - promote French PV industrials on the French market
    - improve confidence of relationships between PV buyers and sellers
    - promote cleaner modules

  - ✓ Seal of approval given to a PV module (not a producer)
  - ✓ Certification (initial) audit + annual audit
  - ✓ 4 product label categories (1-4 stars)
    - ★ LCA in progress + recycling commitment
    - ★★ Same as above, + customer service standards
    - ★★★ Same as above, + quality and traceability standards (ISO 9001-type)
    - ★★★★ Same as above, + resistance tests (heat, water, fire)

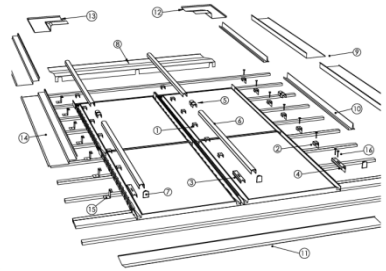
Examples of BIPV solutions – *According to legal definition (1/5)*

- **BIPV: Substitution PV slates or tiles**
  - ✓ Watertightness by overlapping laterally and in the slope direction
  - ✓ Roof boarding shield (textile type) for condensation

Solar Century C21e

Sunland 21 Sunny Home

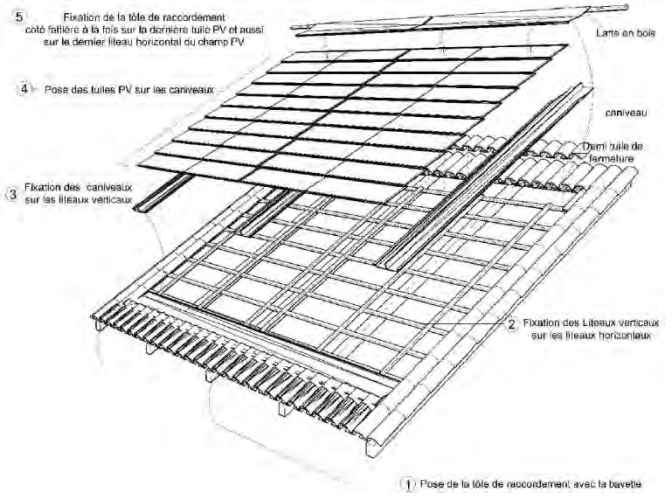
Dupont Gevity



Tuiles et éléments d'étanchéité du champ * :

①③ CAVALIER	⑩ ABERGEMENT LATERAL FINITION
②④ CAVALIER ABERGEMENT	⑪ ABERGEMENT BAS
⑤ MANCHON	⑫ ETANCHEITE DE COIN DROIT
⑥ PROFIL ETANCHE	⑬ ETANCHEITE DE COIN GAUCHE
⑦ BOUCHON PROFIL	⑭ ABERGEMENT LATERAL VOLIGE
⑧ ABERGEMENT HAUT	⑮ PATTE ABERGEMENT VOLIGE
⑨ ABERGEMENT LATERAL	⑯ VIS

* Partie Electrique : onduleur et coffrets non illustrés.



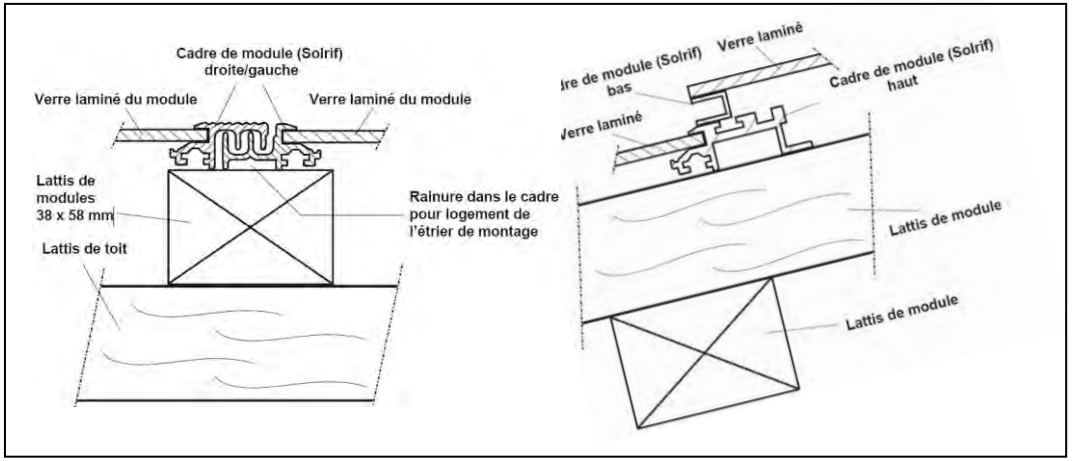
Examples of BIPV solutions – *According to legal definition (2/5)*

- **BIPV: Laminate module with specific frame (such as Solrif® mounting)**
  - ✓ Watertightness by overlapping laterally (overlapping bar, see picture up left) and in the slope direction (EPDM joint)
  - ✓ Specific Solrif® frame (SCHWEIZER metalbau AG)
  - ✓ Roof boarding shield (textile type) for condensation

Schweizer Solrif® aluminum frame (Photowatt®)

Laminate modules roof with Solrif mounting

Watertightness



Examples of BIPV solutions – *According to legal definition (3/5)*

- **BIPV: Watertightness membranes**
  - ✓ PV film mounted at plant or on site
  - ✓ Synthetic, asphaltic (bitumen) or natural (rubber)
  - ✓ Horizontal (0-3°) roofs

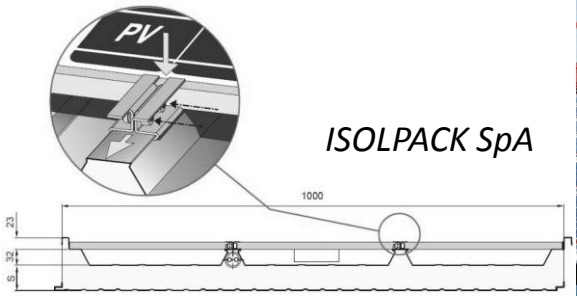
Derbisolar® by Derbigum

Soprasolar® process

Solar Roof® process

Examples of BIPV solutions – *According to legal definition (4/5)*

- **Simplified BIPV: Framed modules mounted on metal structure** requiring a watertightness complement



ISOLPACK SpA

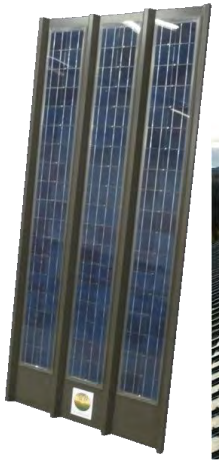
Intersol

Bearing plate + fastener

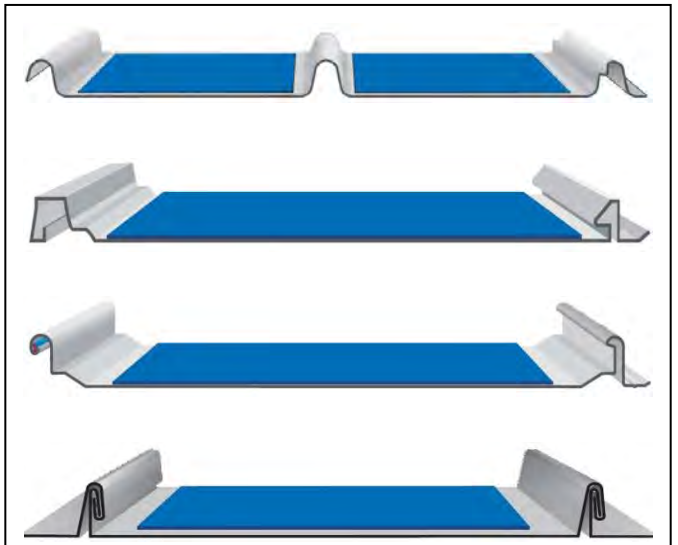
3i Plus SIT®

Examples of BIPV solutions – *According to legal definition (5/5)*

- Simplified BIPV: Laminate module directly stuck on support



Sunny Steel® by Sunland 21

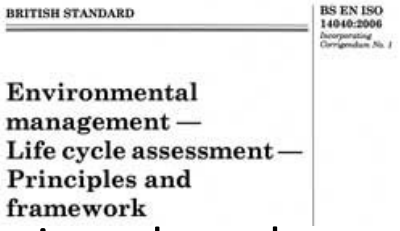


Upside down:

- *Visible attachments (ribbed tray)*
- *Tray with standing seam*
- *Tray with watertight standing seam*
- *« Double clamping » method*

Environmental impacts of PV systems – *Critical parameters 1/8*

- Environmental impacts given by Life Cycle Assessment (LCA) projects of PV systems: **ESPACE projects**


BRITISH STANDARD

BS EN ISO 14040:2006

Environmental management — Life cycle assessment — Principles and framework

  - ✓ LCA: an internationally acknowledged standardized method (ISO 14 040 and following)
  - ✓ A cradle-to-grave approach, with comparable hypothesis and results
  - ✓ ESPACE projects: environmental impacts of PV systems by their LCA
    - co-financed by ADEME (French Environment and Energy Management Agency) since 2008
    - carried out with 4 partners including Transénergie:

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

CYCLeco Analyse du Cycle de Vie

ARMINES

PHK CONSULTANTS

trans|énergie L'énergie du développement durable

    - *Results available on www.espace-PV.com*

Environmental impacts of PV systems – *Critical parameters 2/8*

- ESPACE projects: two different types of systems analyzed
  - ✓ Individual (3 kWp) rooftop PV systems – Functional unit:

    « The kWh of electricity produced by a 3kWp PV installation, considering 1 440 kWh/m².yr of irradiation on an inclined plane (30°) and 30 years of life expectancy. »

  - ✓ Large-scale (5 MWp) ground-mounted PV systems

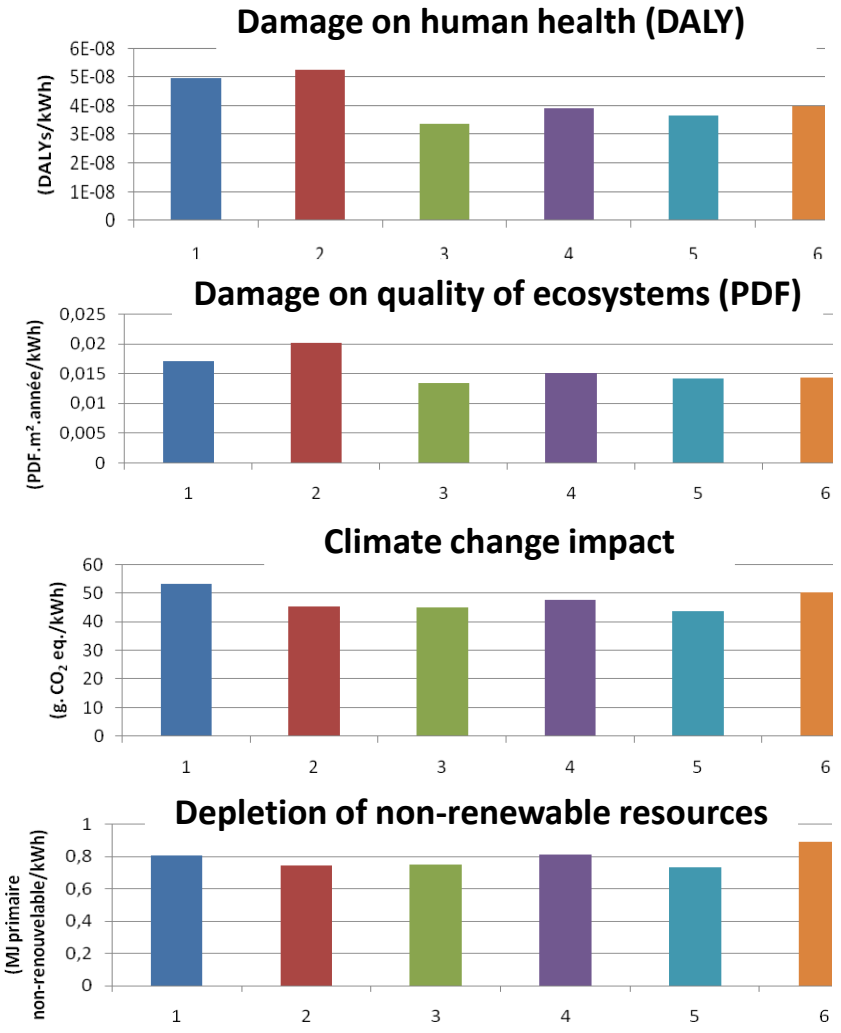
    « The kWh of electricity produced by a 5MWp ground-mounted PV installation, considering 1 440 kWh/m².yr of irradiation on an inclined plane (30°) and 30 years of life expectancy. »

Environmental impacts of PV systems – *Critical parameters 3/8*

- Cells technology comparison: a minor influence

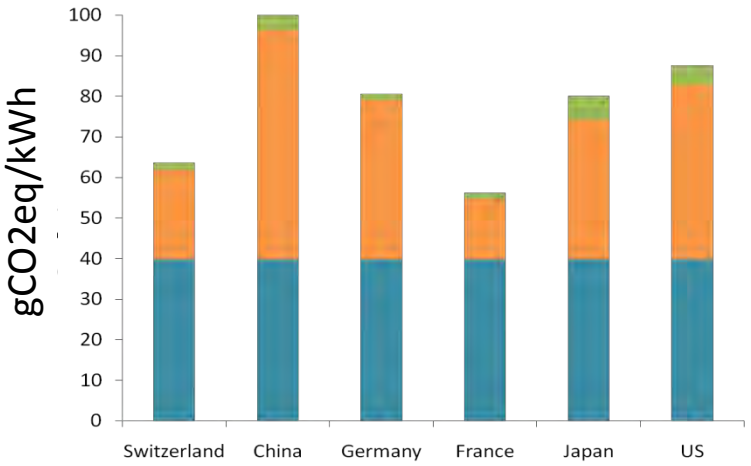
Characteristics					
	Technology	System efficiency (η) (%)	Peak power	Orientation of the system	Type of installation
1	a-Si	6.5	3 kW_p	30° tilt and South orientation	**superimposed**
2	CdTe	7.6			
3	CIS	10.7			
4	mc-Si	13.2			
5	ribbon-Si	12.0			
6	sc-Si	14.0			

	Technology	Type of module	Energy mix used for the fabrication of modules	Installation location	Annual irradiation in the plane of the modules
1	a-Si	framed	**Average of European market**	Lyon, France	1440 kWh/m²
2	CdTe				
3	CIS				
4	mc-Si				
5	ribbon-Si				
6	sc-Si				



Environmental impacts of PV systems – *Critical parameters 4/8*

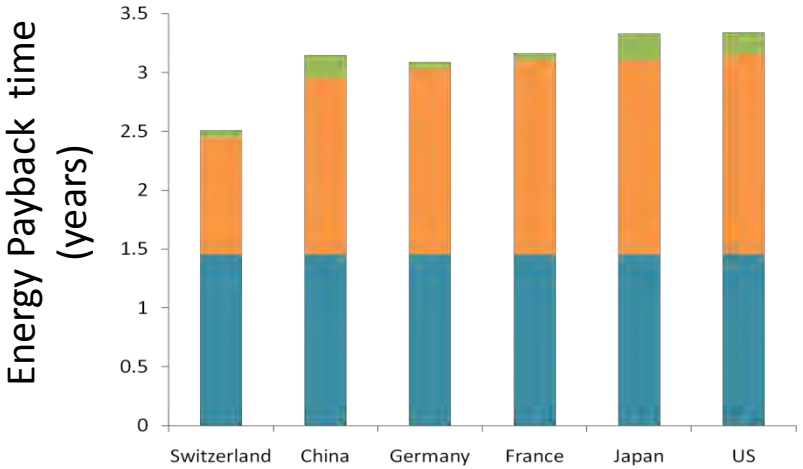
- Energy mix for modules production: a critical parameter…



Transport

Electricity used for the module fabrication

Other process and materials

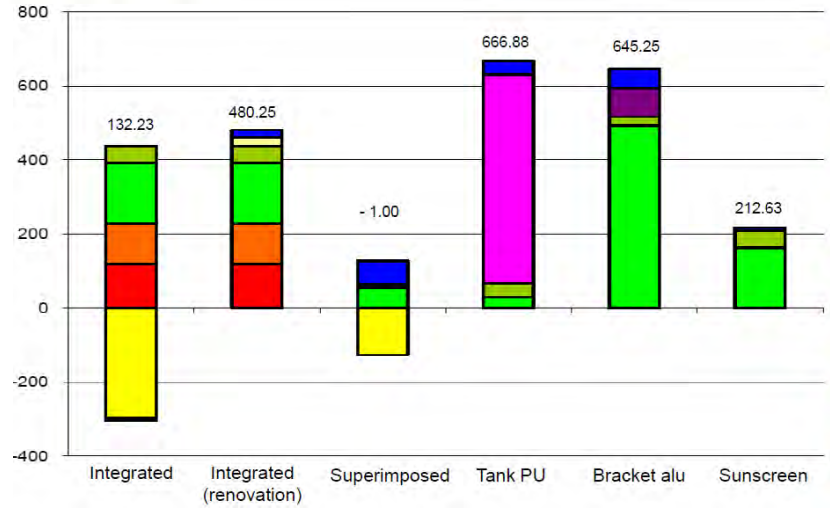


✓ **… in favor of hydraulic or low carbon energy mixes**

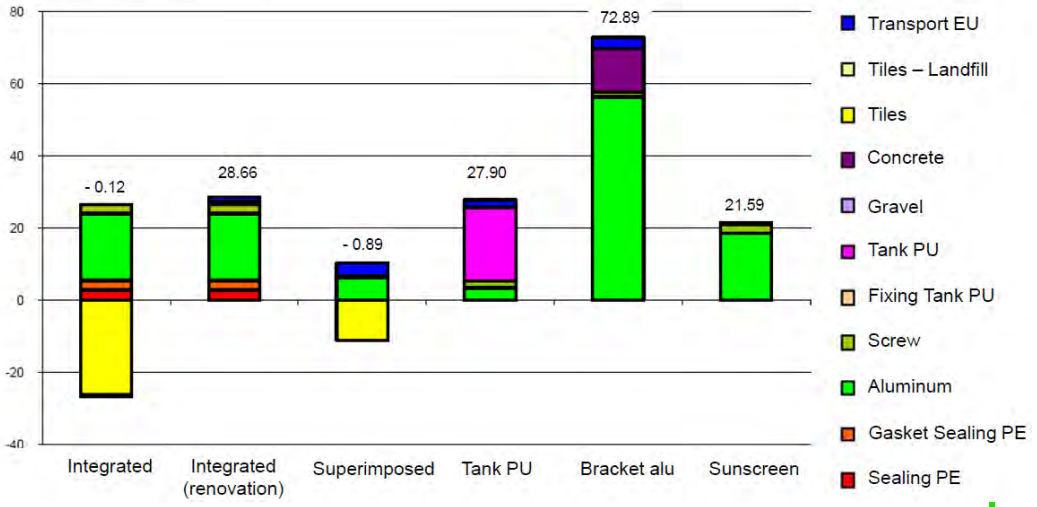
Environmental impacts of PV systems – *Critical parameters 5/8*

- Type of rooftop installation: a critical parameter…

Depletion of non-renewable resources (MJ primary)



Impacts on Climat Change (gCO2eq/kWh)



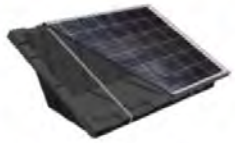
- ✓ … in favor of BIPV and superimposed

Slanted roof

Scenario 1 – Integrated
Scenario 2 – Integrated (renovation)

Scenario 3 – Superimposed

Flat roof



Scenario 4 – Tank PU

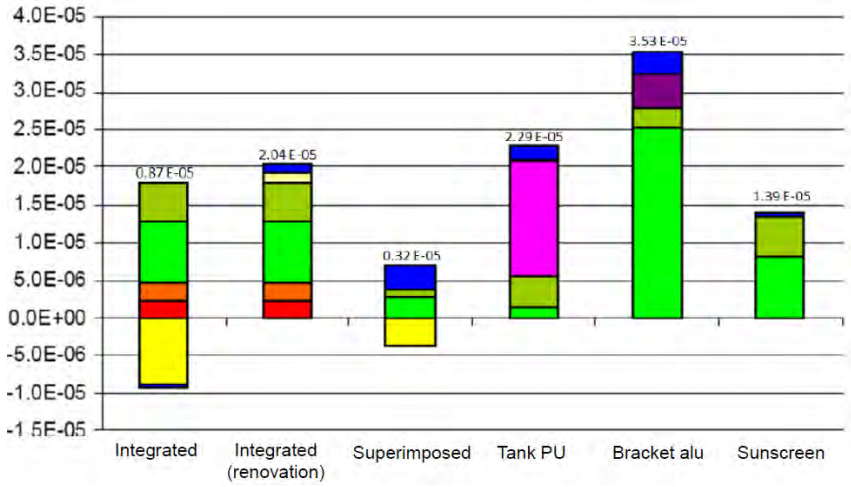
Scenario 5 – Bracket alu

Scenario 6 – Sunscreen

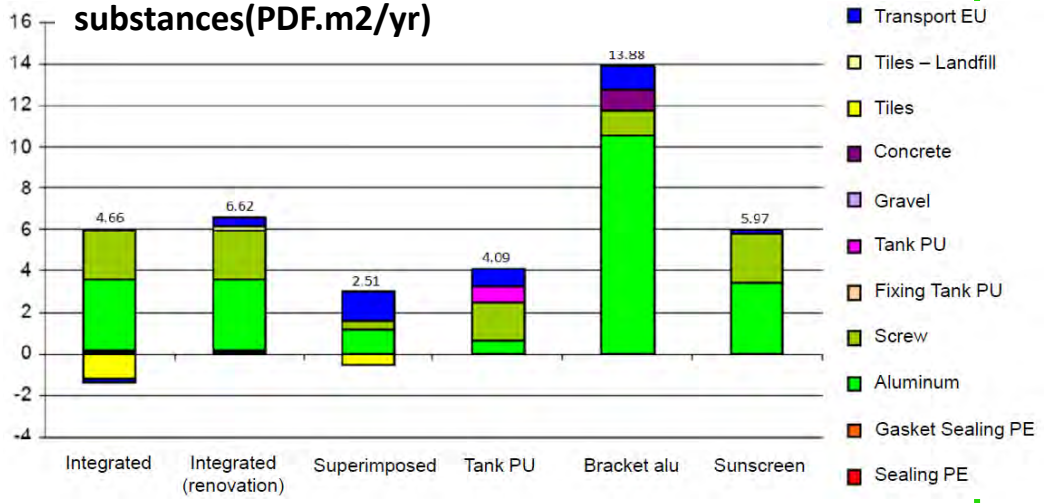
Environmental impacts of PV systems – *Critical parameters 6/8*

- Type of rooftop installation: a critical parameter…

Impact on human health (DALY)



Impact on Ecosystems due to emitted substances(PDF.m2/yr)



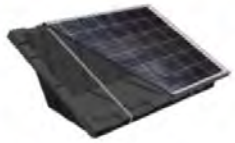
- ✓ … in favor of BIPV and superimposed

Slanted roof

Scenario 1 – Integrated
Scenario 2 – Integrated (renovation)

Scenario 3 – Superimposed

Flat roof



Scenario 4 – Tank PU

Scenario 5 – Bracket alu

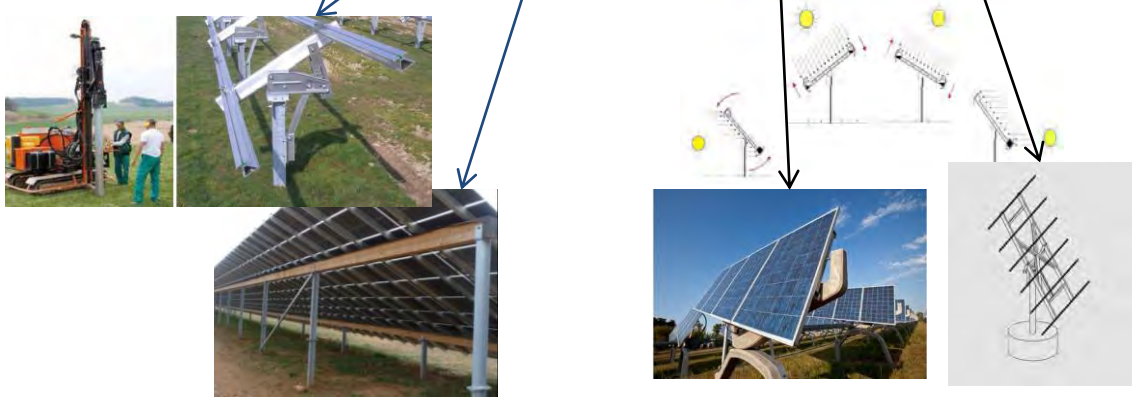
Scenario 6 – Sunscreen

Environmental impacts of PV systems – *Critical parameters 7/8*

- Type of support structure for ground-mounted PV systems: a critical parameter?

Scenarios key features

Scenarios	1	2	3	4
Module Technology	mc-Si	mc-Si	mc-Si	mc-Si
Structure key features	Fixed mounting Primary aluminum supports	Fixed mounting Wood-based supports	Mobile Single-axis trackers	Mobile Dual-axis trackers



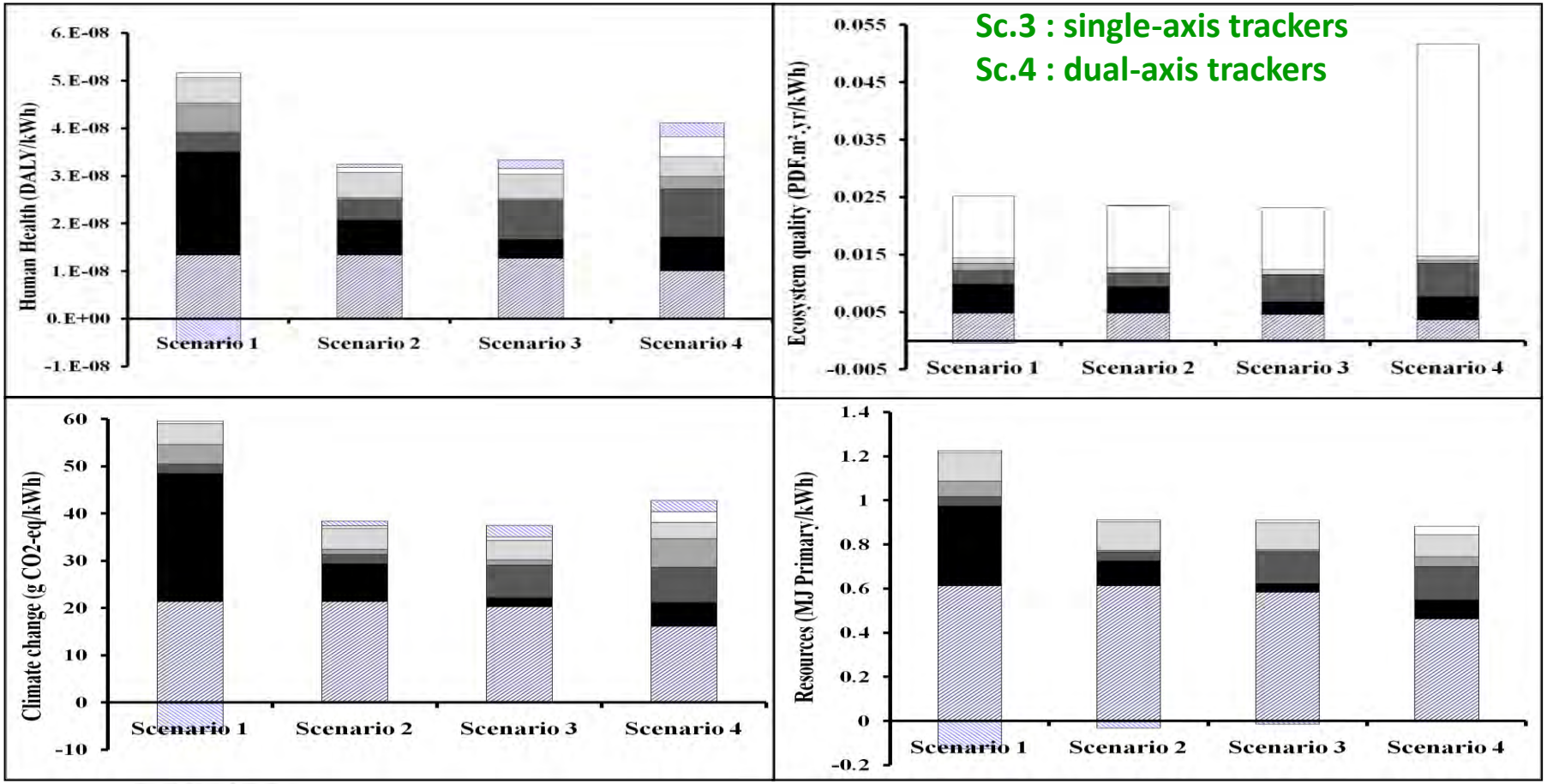
For a 5MWp PV system

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Modules	35714 m² - value based on calculations from energy production performances			
Area	92 888 m²	92 888 m²	96 922 m²	418 770 m²
Supports	Primary aluminum – Mass values from technical sheets from a German manufacturer	Wood, primary aluminum and iron – Mass values from data from a multi-MWp installation in France	Galvanized steel – Mass values from technical sheets from a Spanish manufacturer	Galvanized steel – Mass values from technical sheets from an Italian manufacturer

Environmental impacts of PV systems – *Critical parameters 8/8*

- Ground-mounted PV installations:

Sc.1 : aluminum fixed mounting
Sc.2 : wood-based fixed mounting
Sc.3 : single-axis trackers
Sc.4 : dual-axis trackers



Thank you for your attention

Vielen Dank für ihre Aufmerksamkeit

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