



Solaire photovoltaïque pour le bâtiment et analyse de cycle de vie

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Hespul

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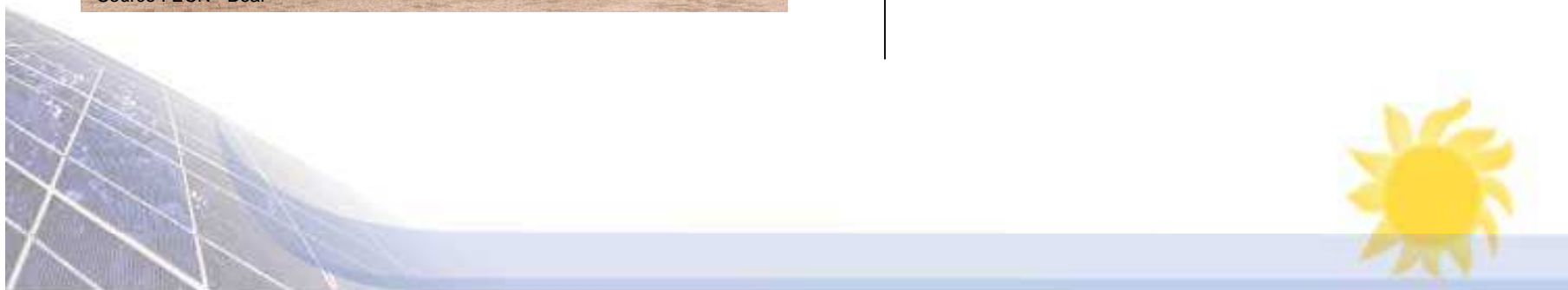
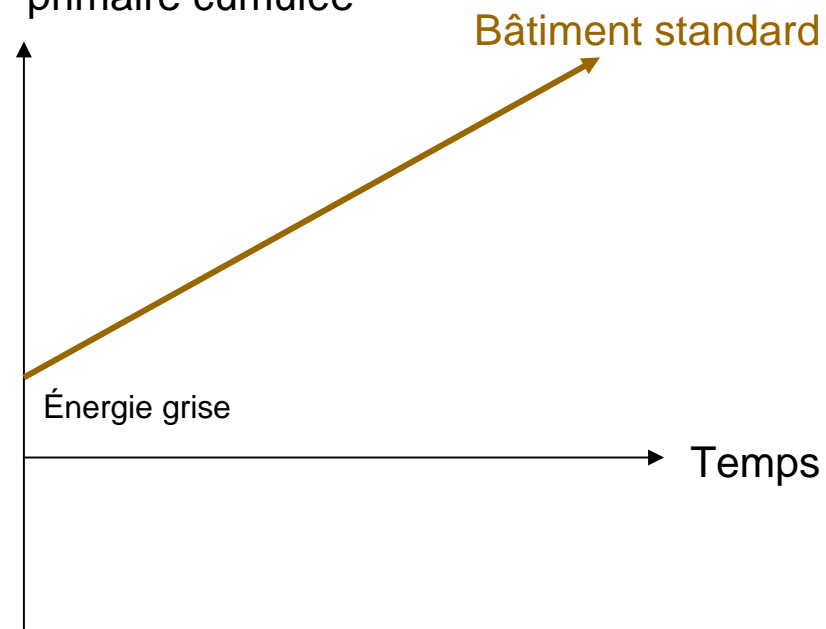


Énergie et bâtiments



Source : ECN - Bear

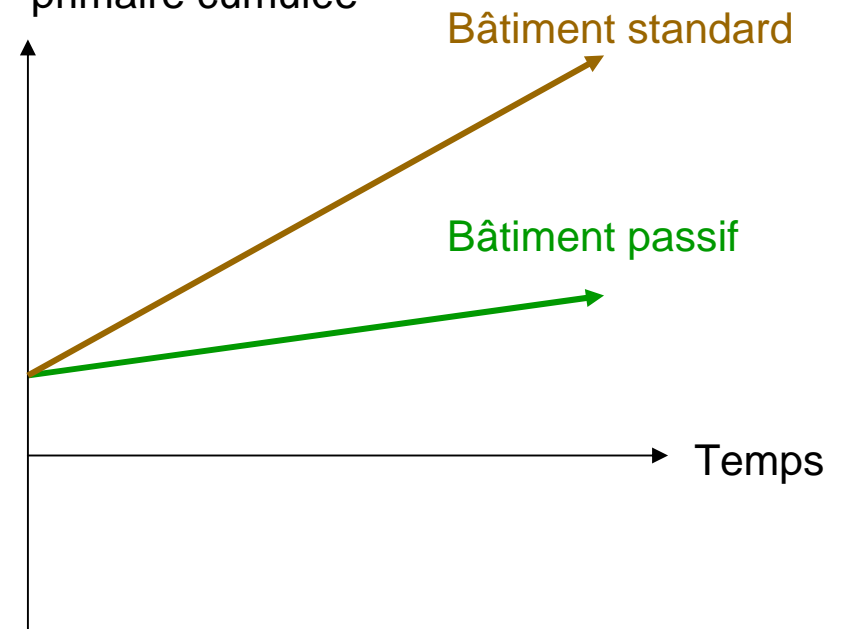
Consommation d'énergie
primaire cumulée



Énergie et bâtiments



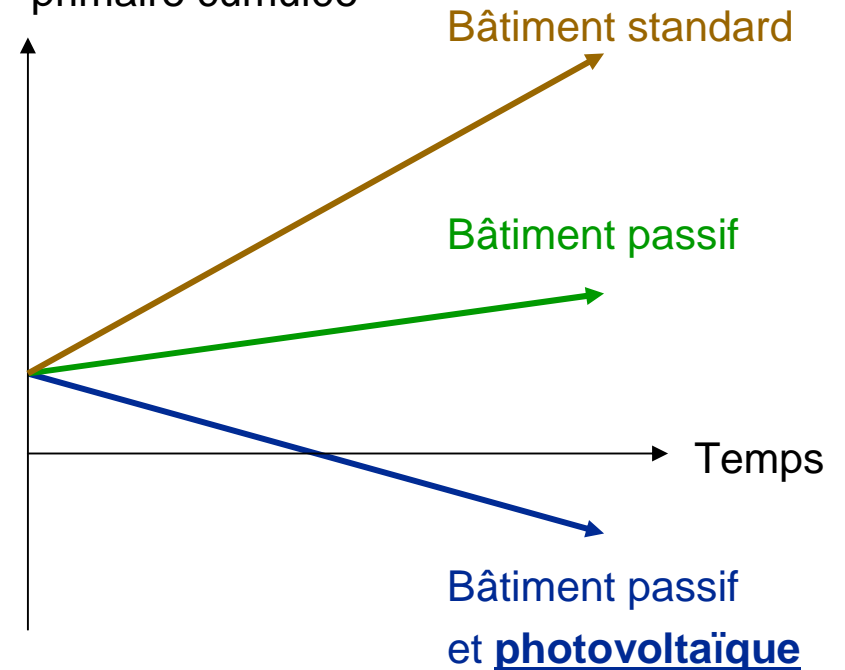
Consommation d'énergie
primaire cumulée



Énergie et bâtiments



Consommation d'énergie
primaire cumulée



Électricité et bâtiment



Académie du Mont-Cenis – 1 MW Herne – Allemagne

Consommation d'électricité : 225 000 kWh

Production photovoltaïque : 750 000 kWh

Taux de couverture : 330%



Bureaux Hespul Villeurbanne

Consommation d'électricité : 6 000 kWh

Production photovoltaïque : 6 500 kWh

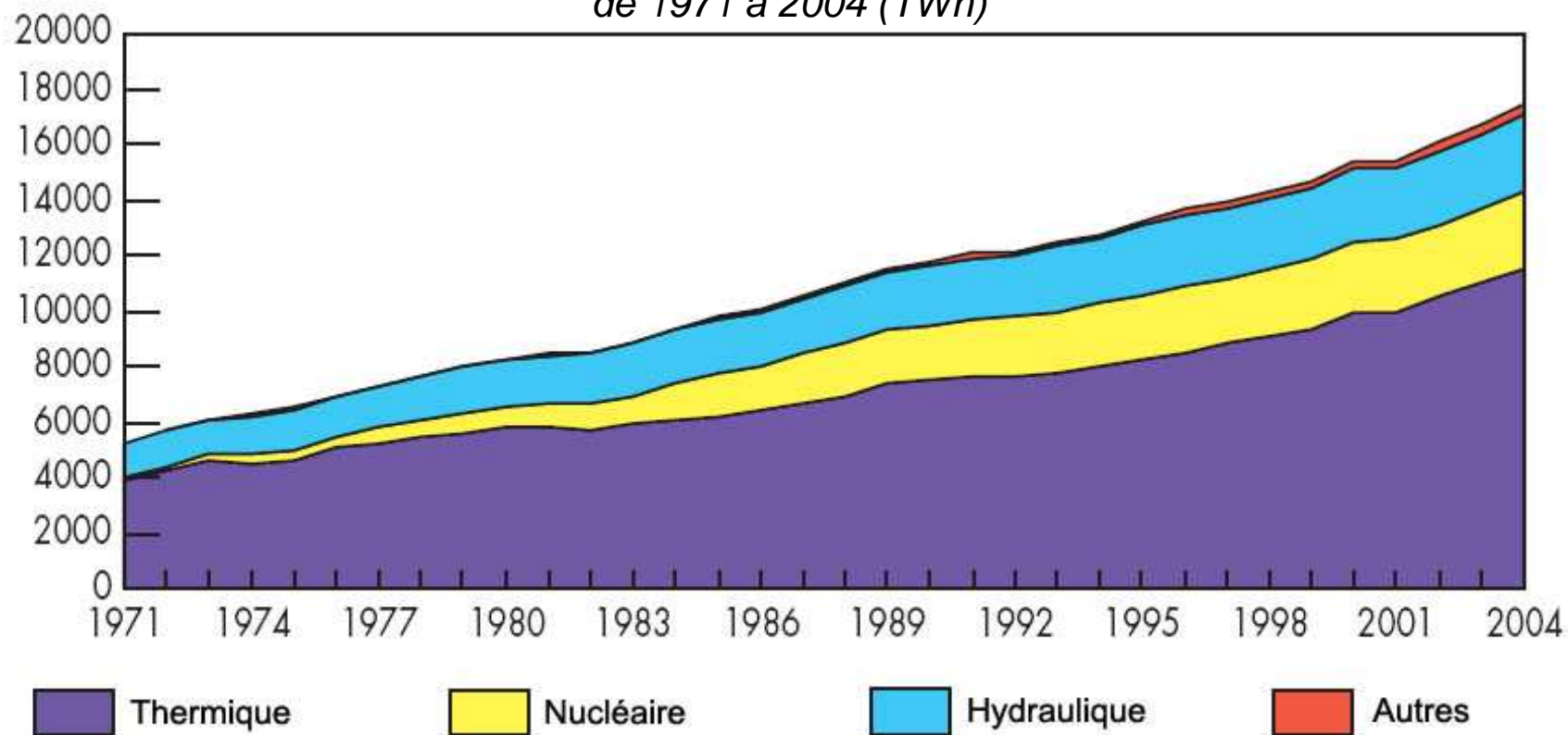
Taux de couverture : 110%



L'électricité dans le monde



Évolution de la production d'électricité dans le monde
de 1971 à 2004 (TWh)



Source : Key World Energy Statistics – IEA

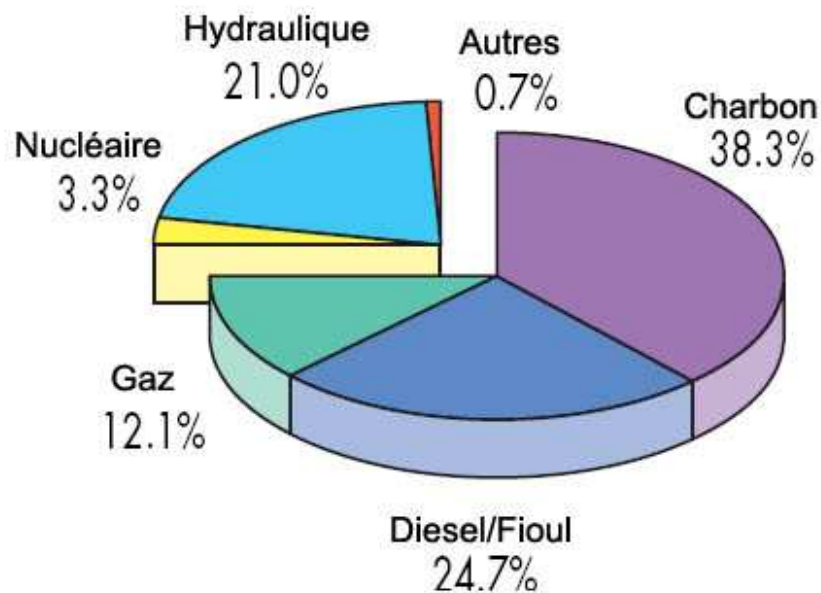


L'électricité dans le monde



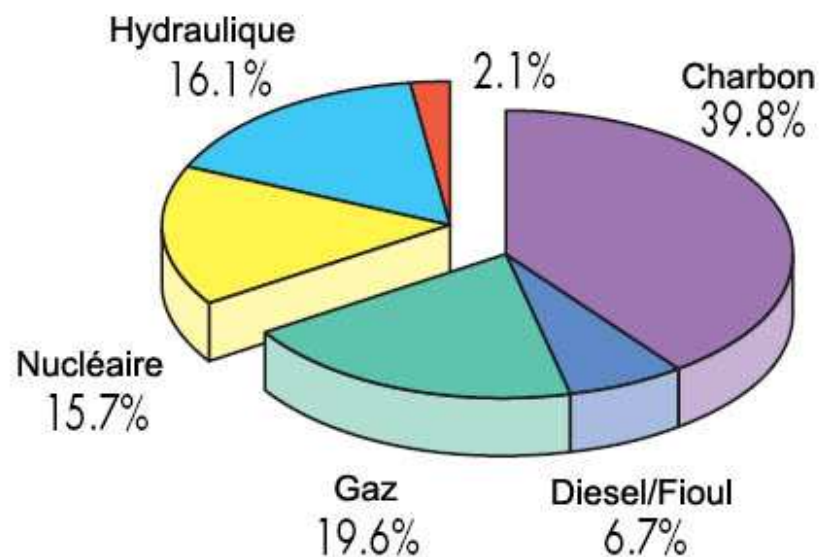
Évolution de la production d'électricité dans le monde
de 1971 à 2004 (TWh)

1973



6 117 TWh

2004



17 450 TWh

Source : Key World Energy Statistics – IEA



L'électricité en France en 2005



	Montant en TWh	Evolution en TWh	Evolution en %	
Production nette (1)	549,4	0,3	0,1%	
<i>dont :</i>				
<i>nucléaire</i>	430,0	2,3	0,5%	78,3 %
<i>thermique classique</i>	62,2	6,1	11,0%	11,3 %
<i>hydraulique</i>	56,2	-8,5	-13,1%	10,2 %
<i>éolienne et photovoltaïque</i>	1,0	0,4	60,3%	0,2 %
Importations (2)	8,0	1,5	22,3%	
Exportations (3)	68,3	0,0	-0,1%	
Solde des échanges (4)=(3)-(2)	60,3	-1,5	-2,4%	
Pompages (5)	6,6	-0,7	-9,3	
Energie appelée* (6)=(1)-(4)-(5)	482,4	2,5	0,5%	
<i>dont :</i>				
<i>basse tension</i>	186,9	4,1	2,3%	
<i>haute et moyenne tension</i>	263,7	-1,7	-0,6%	
<i>pertes et ajustements</i>	31,8	0,1	0,3%	

Source: Ministère de l'Industrie



Le photovoltaïque



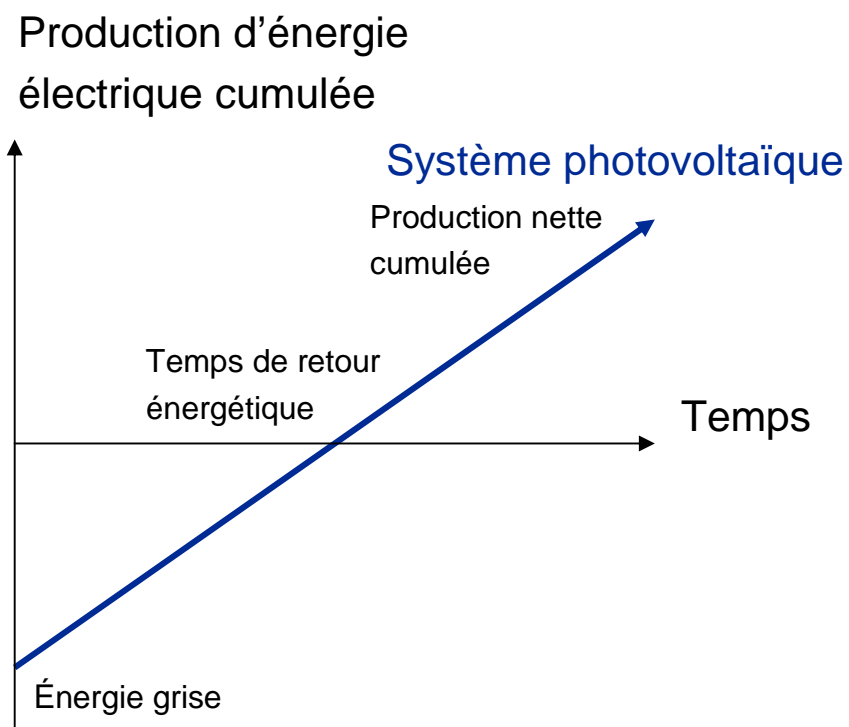
- Production sur site de consommation
- Fabriqué à partir d'une matière première abondante
- Fonctionnement fiable et sans nuisance
- Fort potentiel en milieu urbain
- Faible impact environnemental (recyclabilité)



➤ mais nécessite une quantité importante d'énergie électrique pour sa fabrication !



Temps de retour énergétique



Énergie grise



➤ sujet d'actualité au niveau international

- IEA PVPS Task 12
- EU PV Platform
- CrystalClear project ...

➤ source des données

Alsema, E.A., de Wild-Scholten, M.J., The real environmental impacts of crystalline silicon PV modules : an analysis based on up-to-date manufacturers data, in : 20th European PV Solar Conference, Barcelona, 2005

➤ énergie grise du cycle de vie : 2525 kWh/kWc



THE REAL ENVIRONMENTAL IMPACTS OF CRYSTALLINE SILICON PV MODULES: AN ANALYSIS BASED ON UP-TO-DATE MANUFACTURERS DATA

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ABSTRACT: Together with a number of PV companies an extensive effort has been made to collect LCA Cycle Inventory data that represent the current state of production technology for crystalline silicon modules. The new data covers all processes from silicon feedstock production to cell and module manufacturing. An extended water subcategory at level 4, that is water and mineralization values as well as silicon technology. The presented data should be representative for the technology years 2005, although not necessarily 5% conservative. Further improvement of the data quality is recommended. On the basis of the new data it is shown that PV modules on the basis of cell technology are on a grid position to compete with other energy technologies. Energy Pay Back Time is 1.5-2.5 yr. on a grid of Dutch European location, while life cycle CO₂ emissions are in the 20-40 g/kWh range. Clear perspectives exist for further improvements with respect to LCA.

Keywords: Environmental Impact, Life Cycle Assessment, LCA

1. INTRODUCTION
 Reliable data on the environmental impact of PV module manufacturing has been scarce since the late 1970's. The only available data collection based on production data was presented at PVSEC 2002 and was based on technology from the late 90's. Later work on data to update these data led to the work in a large effort based on necessary data sources and estimates [1, 2, 3, 4]. Consequently, life cycle assessment and related cost studies were often based on the older data as that does not really reflect the technological progress made over the last decade.

In a recent collaboration with other PV companies from Europe and the US, we have made a plan to improve this situation. The contributing companies together cover the complete production chain for crystalline silicon PV modules, from poly-silicon production to module assembly. All data cover all life cycle sub-categories for cell, module manufacturing, transportation and above, liquid water subcategory. This effort was conducted in the framework of the CrystalClear project, a large European Commission funded program focused on many inter-related clean technology.

In a first step we have prepared together with the industrial partners, an overview of all life cycle inventory data based on real measured data from production lines. Based on these data, the CrystalClear Assessment study has been performed. Preliminary results of this work are presented in this paper.

2. DATA COLLECTION AND PROCESSING
 As mentioned we were able to obtain the cooperation of nine PV companies which together cover the current production capacity of silicon PV modules. An industrial and energy consumption data was directly collected at the manufacturing facilities to be representative for the current state. Also many companies had to make a special effort to collect the required data.

Because one of our aims is to prepare a representative set of Life Cycle Inventory data sets on measured and usage inputs, as well as emissions per process step we tried to get at least three data suppliers for each process step and process technology in a given LCA module. In this way we could provide average LCI data without causing proprietary information. The data was limited to a large extent but in some cases of the production technology specific data to the data collector work more time of the process was not well covered it had to be used to make use of existing data from literature. Also we needed to aggregate the process data into a main process step, as shown in Table 1.

For silicon feedstock production we had one set of new data, which we aggregated with existing data from literature [2, 3]. For transportation and utility of feedstock, silicon we had data sets from three different, but the same goal to obtain production. Among the different manufacturing technologies, silicon flow is not process specific, which makes it a good candidate for the purpose of data aggregation we considered data in a conservative manner. Nevertheless, the aggregated silicon process data can be considered as representative for larger technology.

Table 1. Overview of data sources used for the analysis in this paper. 'New data' refers to manufacturers data collected over the past year while the 'CrystalClear project' denotes data coming from literature of first life cycle inventory studies.

Subcategory	Module 1	Module 2	Module 3	Module 4
Feedstock	new data	new data	new data	new data
Transportation	new data	new data	new data	new data
Utility	new data	new data	new data	new data
Cell production	new data	new data	new data	new data
Module	new data	new data	new data	new data
Installation	new data	new data	new data	new data

For mono-crystalline silicon sheet production and cutting there is a substantial data source discrepancy in the data. We did not have data for sheet production or measured data from sheet production. We used information on some additional process improvements [2]. This was aggregated with data from literature [2]. Because of the observed discrepancy and inconsistency and the low of relative importance of this process step we decided to improve on the data accuracy and representation.



Systemes photovoltaïques



- **Meilleur cas : toiture plein sud**
- **Cas défavorable : façade photovoltaïque**



- **Technologie actuelle disponible sur le marché**
- **Localisation : 41 villes des pays de l'OCDE**



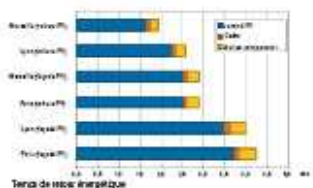
Résultats pour la France



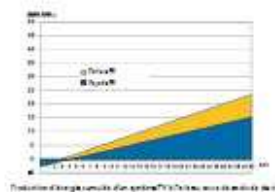
FRANCE 

International Energy Agency-Photovoltaic Power Systems Programme
European Photovoltaic Technology Platform
European Photovoltaic Industry Association

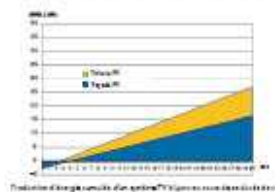
Etude comparative d'une sélection d'indicateurs à moyen terme relatifs
à l'électricité solaire photovoltaïque (PV) dans les villes de l'OCDE



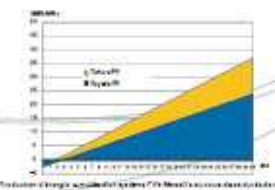
Paris	Rayonnement global horizontal 1023 kWh/m ²	
	Toiture PV	Façade PV
Production annuelle [MWh/kWc]	672	585
Temps de retour énergétique [ans]	2,50	4,08
Coefficient de performance énergétique [-]	6,4	6,1
Potentiel de réduction des émissions de CO ₂ [tCO ₂ /kWc]	2,095	1,428



Lyon	Rayonnement global horizontal 1204 kWh/m ²	
	Toiture PV	Façade PV
Production annuelle [MWh/kWc]	994	632
Temps de retour énergétique [ans]	2,57	4,00
Coefficient de performance énergétique [-]	10,7	6,5
Potentiel de réduction des émissions de CO ₂ [tCO ₂ /kWc]	2,364	1,518



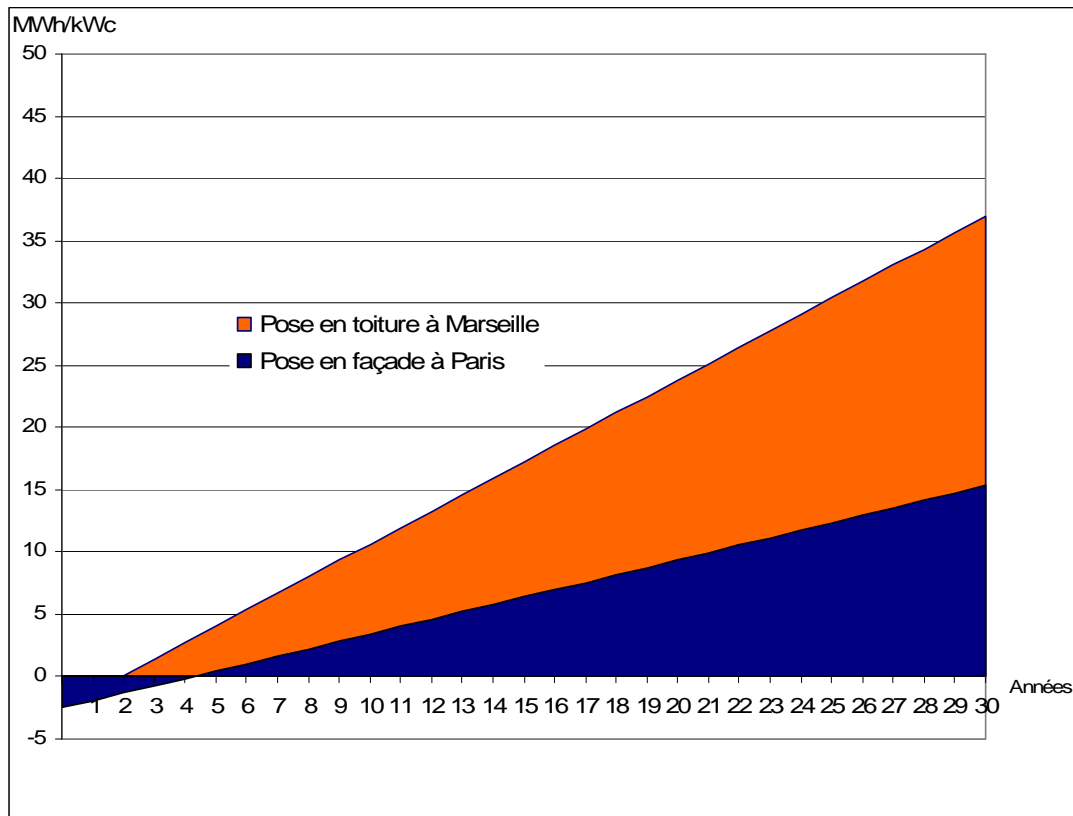
Marseille	Rayonnement global horizontal 1540 kWh/m ²	
	Toiture PV	Façade PV
Production annuelle [MWh/kWc]	1,217	676
Temps de retour énergétique [ans]	1,50	3,08
Coefficient de performance énergétique [-]	14,6	9,4
Potentiel de réduction des émissions de CO ₂ [tCO ₂ /kWc]	2,162	2,308



Lyon	Rayonnement global horizontal 1204 kWh/m ²	
	Toiture PV	Façade PV
Production annuelle [kWh/kWc]	984	632
Temps de retour énergétique [ans]	2,57	4,00
Coefficient de performance énergétique [-]	10,7	6,5
Potentiel de réduction des émissions de CO ₂ [tCO ₂ /kWc]	2,364	1,518



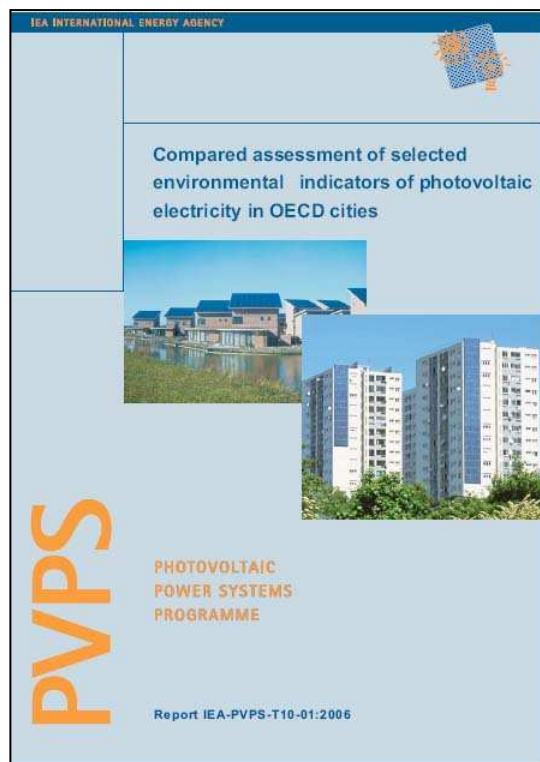
Résultats pour la France



	Temps de retour énergétique	Coefficient de performance énergétique
Système photovoltaïque en toiture à Marseille	1,9 ans	14,6
Façade photovoltaïque à Paris	4,3 ans	6,1



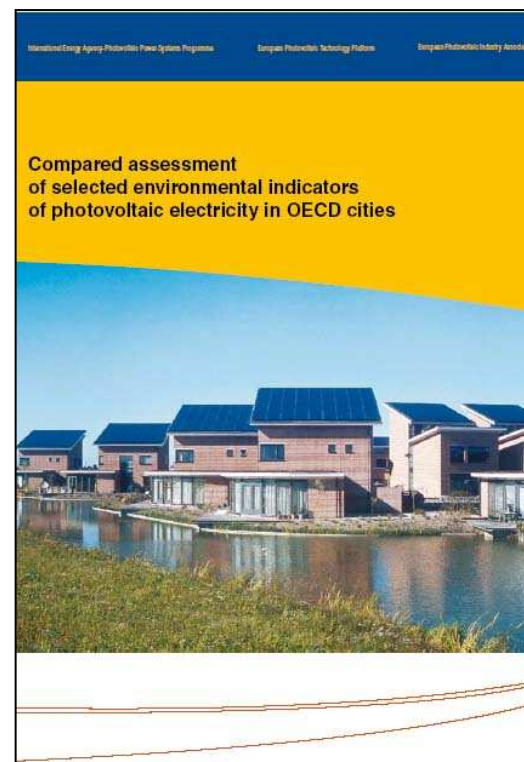
Rapports disponibles



Rapport complet (pdf)

www.iea-pvps.org

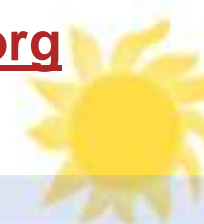
www.iea-pvps-task10.org



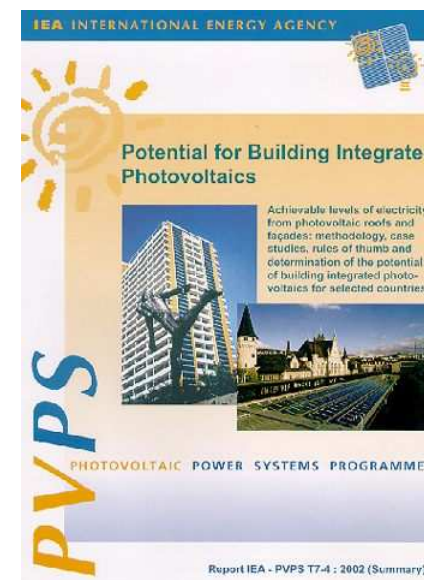
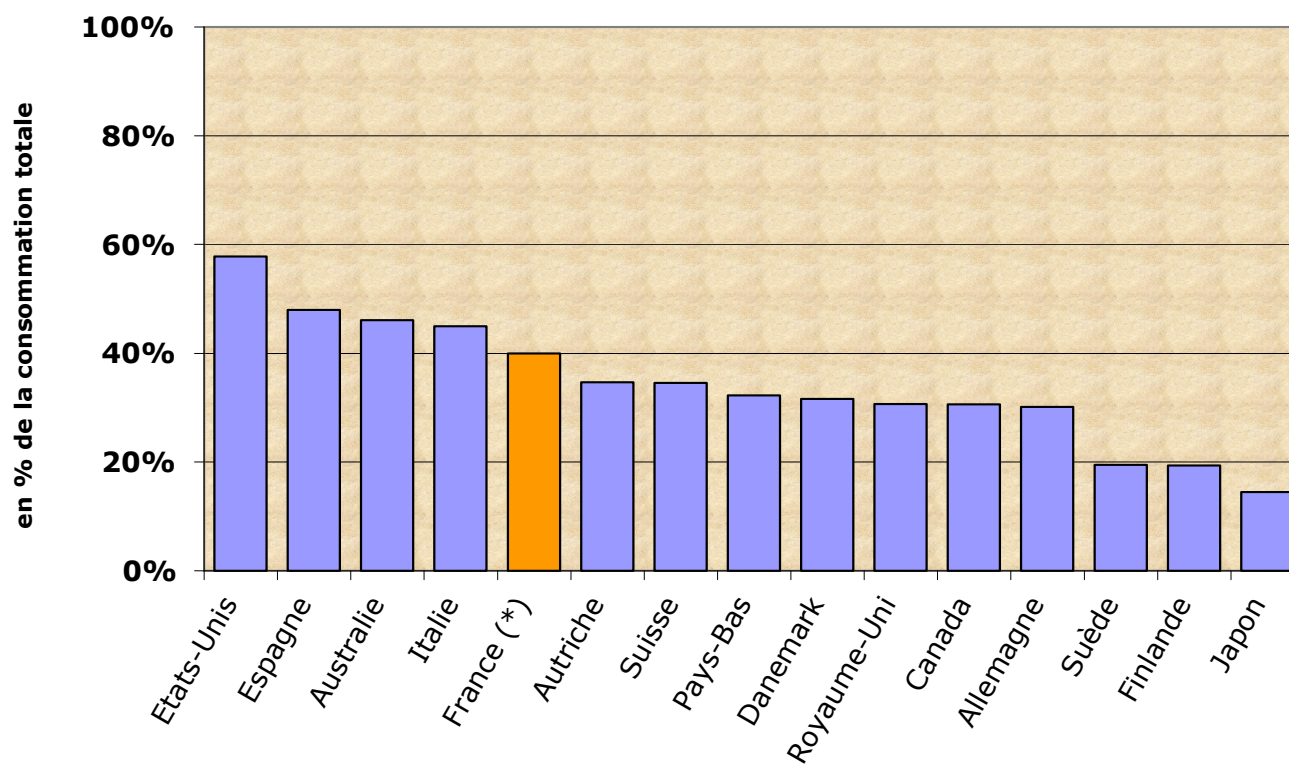
Résumé et fiches pays (papier)

www.epia.org

www.eupvplatform.org

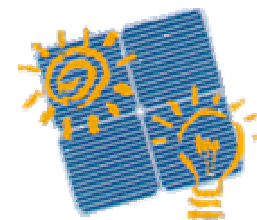


Étude du potentiel de fourniture d'électricité PV



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ADEME





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