

**Réalisation d'une ligne pilote de production  
de panneaux solaires flexibles (100kW/an)  
(Projet OFEN No 100540)**

Symposium photovoltaïque national  
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Alexandre Closset, CEO VHF-Technologies SA

1. Motivations
2. Historique des défis technologiques
3. Exemples de réalisations
4. Perspectives



**Baalbeck – Liban: le plus grand Temple de Jupiter construit il y a 2000 ans par les Romains**

**1 heure d'ensoleillement sur la surface du globe terrestre = 1 x la consommation énergétique mondiale annuelle...**



# L'AIE fait du prosélytisme dans 14 pays...

Potentiel BIPV de 23 milliard de m<sup>2</sup> = 1000GW<sub>p</sub> @ 5% d'efficacité!

<i>BIPV area potential (in km<sup>2</sup>)</i>		<i>Residential buildings</i>	<i>Agriculture buildings</i>	<i>Industrial buildings</i>	<i>Commercial buildings</i>	<i>Other buildings</i>	<i>All buildings</i>
Australia	Roof	373.50	22.50	6.00	16.5	3.75	422.25
	Façade	140.06	2.81	2.25	8.25	1.41	158.34
Austria	Roof	85.65	17.13	15.19	17.45	4.20	139.62
	Façade	32.12	2.14	5.70	8.73	1.58	52.36
Canada	Roof	727.20	36.36	60.60	133.32	6.06	963.54
	Façade	272.70	4.55	22.73	66.66	2.72	361.33
Denmark	Roof	50.88	14.84	10.60	10.60	1.06	87.98
	Façade	19.08	1.86	3.98	5.30	0.40	32.99
Finland	Roof	78.28	21.01	19.16	8.45	0.41	127.31
	Façade	19.08	1.86	3.98	5.30	0.40	32.99
Germany	Roof	721.78	164.04	229.66	164.04	16.40	1 295.92
	Façade	270.67	20.51	86.12	82.02	6.15	485.97
Italy	Roof	410.26	113.96	136.75	91.17	11.40	763.53
	Façade	153.85	14.25	51.28	45.58	4.27	286.32
Japan	Roof	753.88	40.48	75.89	91.07	5.06	966.38
	Façade	282.71	5.06	28.46	45.54	1.90	362.39
Netherlands	Roof	127.48	42.70	52.75	35.80	0.63	259.36
	Façade	47.81	5.34	19.78	17.90	0.24	97.26
Spain	Roof	251.97	78.74	55.12	55.12	7.87	448.82
	Façade	94.49	9.84	10.67	27.56	2.95	168.31
Sweden	Roof	134.52	36.11	32.92	14.51	0.71	218.77
	Façade	50.45	4.51	12.35	7.26	0.27	82.04
Switzerland	Roof	67.12	21.90	21.05	12.80	15.36	138.22
	Façade	25.17	2.74	7.89	6.40	5.76	51.83
United Kingdom	Roof	601.88	71.09	61.61	168.24	11.85	914.67
	Façade	225.70	8.89	23.10	84.12	4.44	343.00
United States	Roof	6 791.83	322.91	602.76	2 260.36	118.40	10 096.26
	Façade	2 546.94	40.36	226.04	1 130.18	44.40	3 786.10

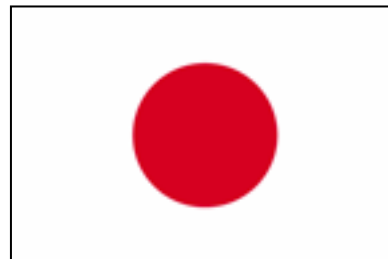
\*Suitable existing roofs and facades with good sunshine exposure in selected 14 IEA countries (source: Report IEA – PVPS T7-4:2002)

# Que fait la compétition internationale?



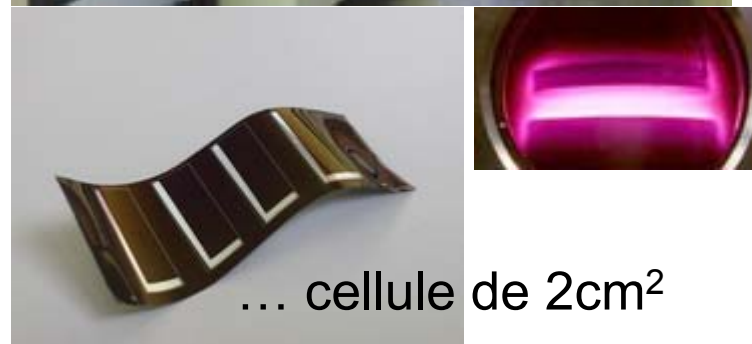
Unisolar, USA

Fuji, Japan



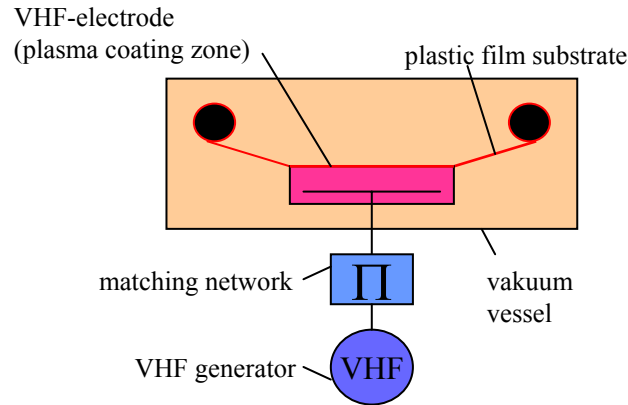


Réacteur plasma stationnaire...



... cellule de 2cm<sup>2</sup>

## Système dynamique 1600 sqm/a



**30cm x 40cm = 0.12 m<sup>2</sup>**

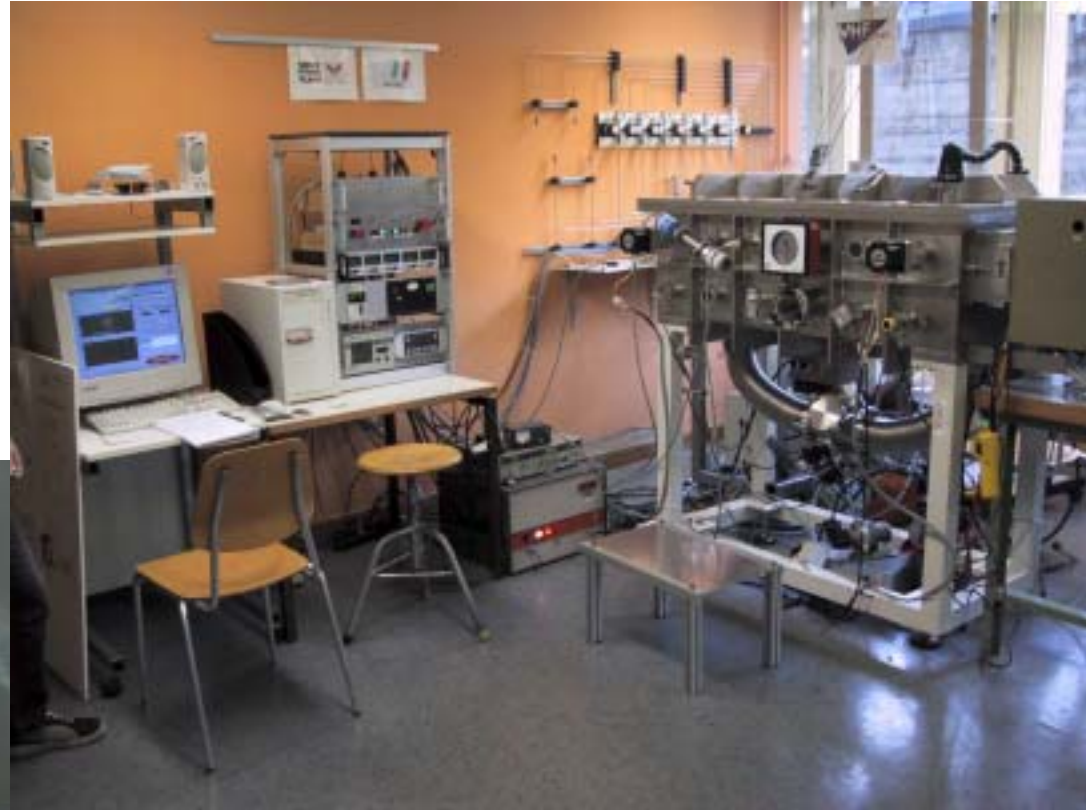
**120m x 30cm / semaine**



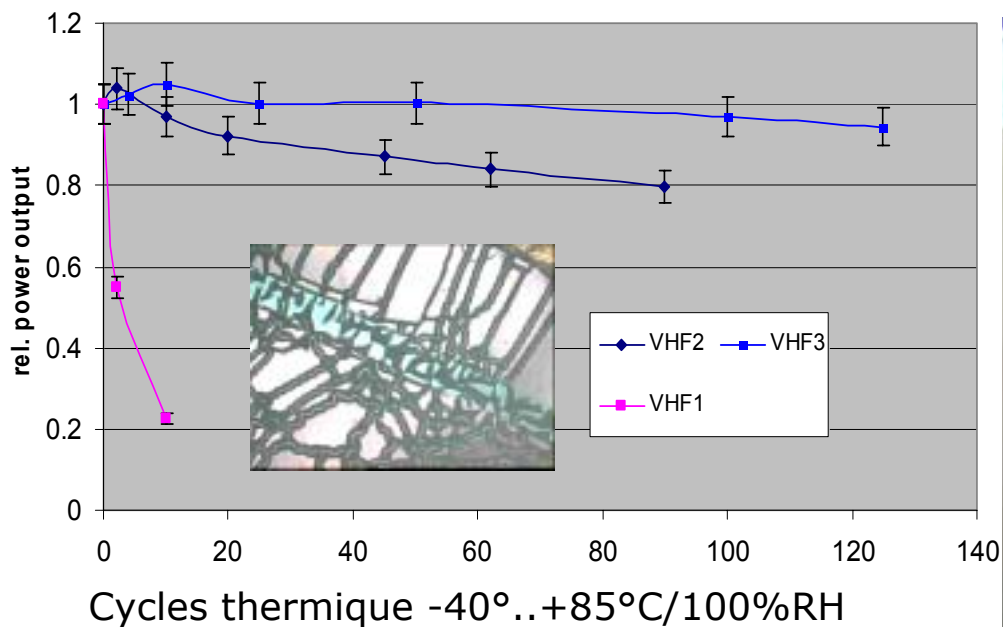
6 ans de travail pour passer  
du plastic brûlé à 120m de  
cellules fonctionnelles



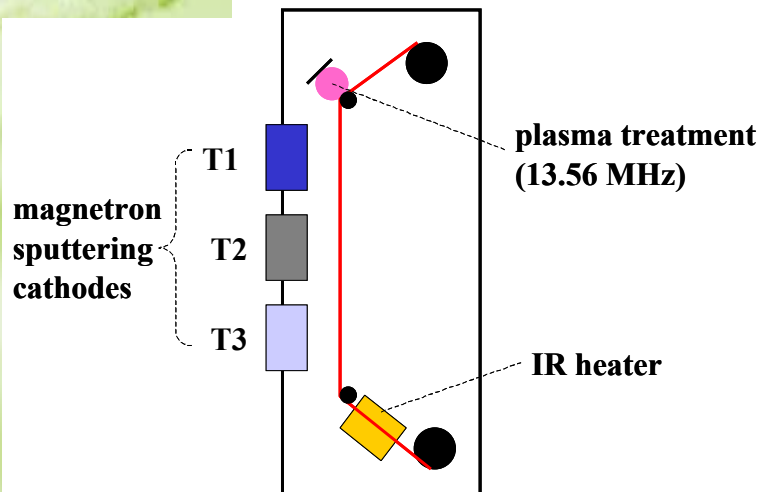
Réacteur plasma VHF continu et « multi-pass » unique au monde pour le dépôt du silicium amorphe



2001-2002: développement de la Mise en série avec un plotter HP récupéré dans une poubelle



(projet OFEN No 100296)



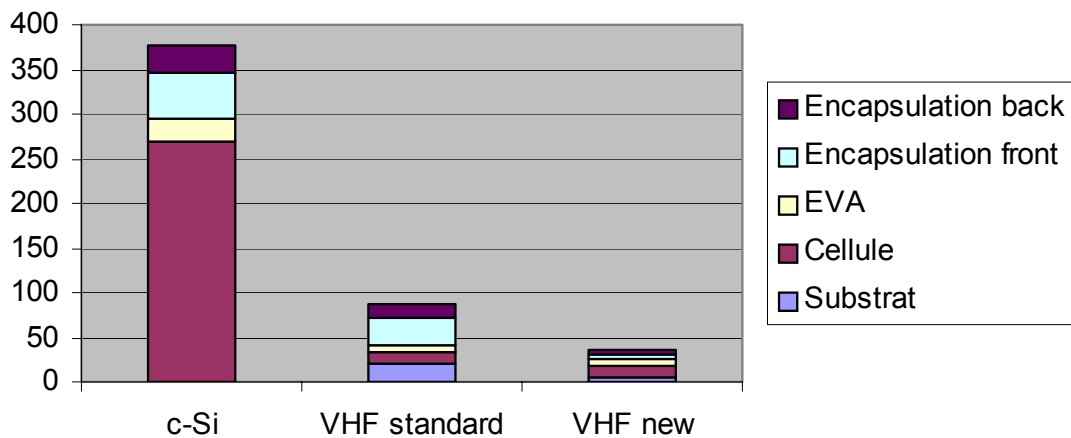


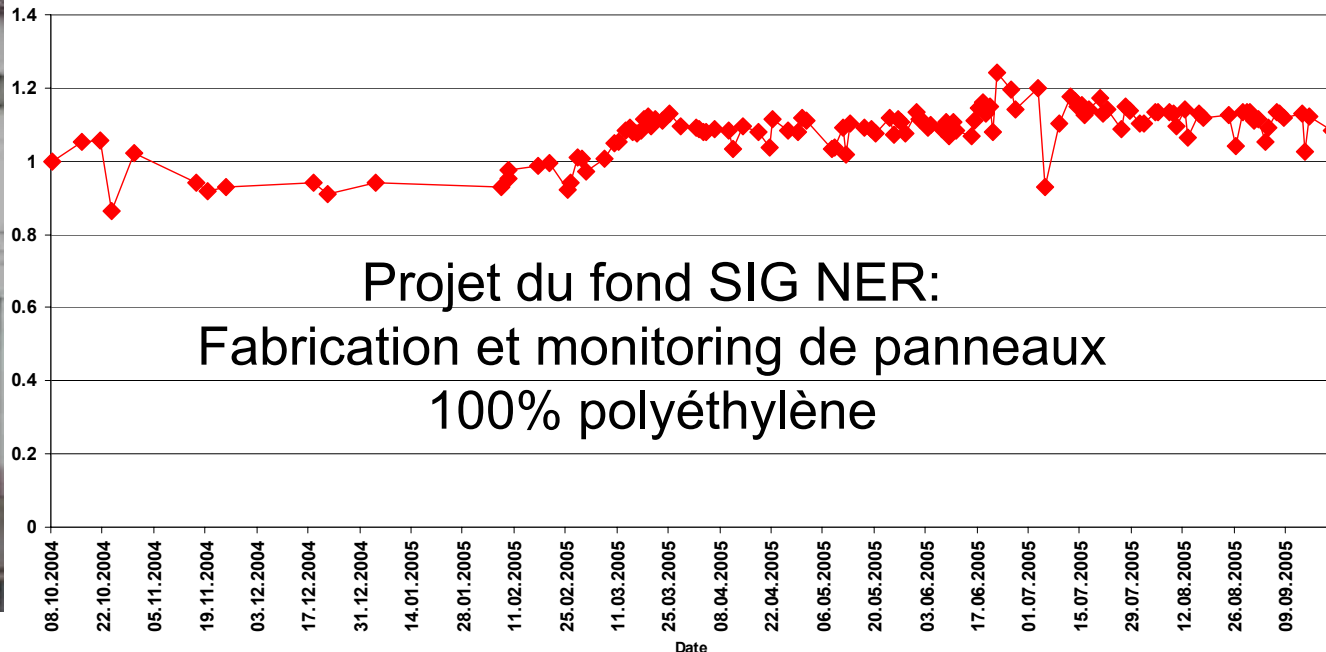


...avec l'utilisation du PET pour l'encapsulation et développements des panneaux thermoformés



### Coûts matériaux (CHF/m<sup>2</sup>)





Projet du fond SIG NER:  
Fabrication et monitoring de panneaux  
100% polyéthylène

## Projet SIL: Développement d'un store PV

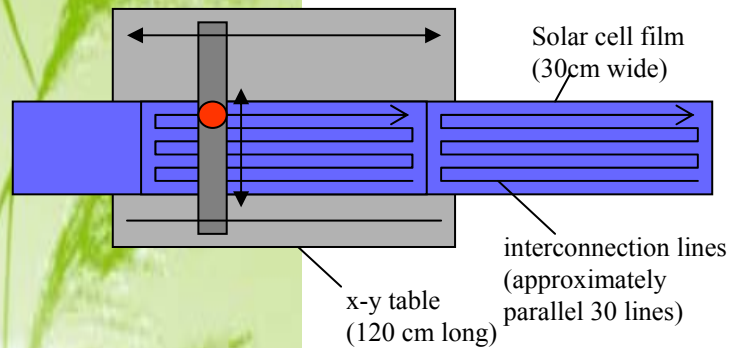


Centrale météo



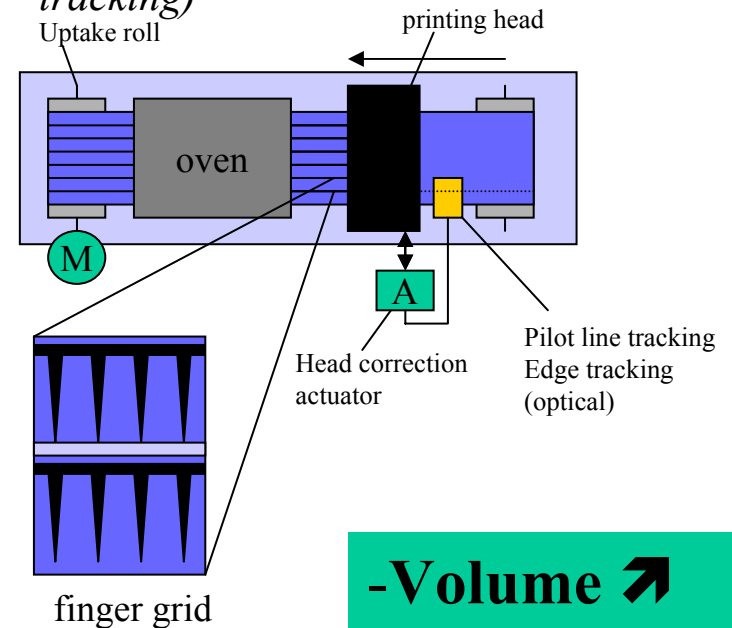
### Current Ag inking process (lines)

*x-y table, 1 batch (1.2 m x 0.3 m) = 30 min*



### Ag printing process (grid)

*continuous  
0.5 meter per minute,  
automatic alignment (optical tracking)*



...et augmentation du rendement à 4% stable (surface active du module)

- Volume ↗
- FF ↗
- Area loss ↘



Impression des lignes d'argent,  
soudage laser et application des  
bandes de cuivre



*sunboard*



semirigid



shockresistant



waterproof

***sunslick***



**flexible**



**do not fold**



**waterproof**

*sunpack*



rollable



do not fold



weatherproof



2 x 120m de rouleau par semaine



50 panneaux par jour

# Vérification d'un modèle de coût de production très prometteur

The detailed cost model worked out by VHF-Technologies and based on its current pilot line process, demonstrate the possibility to reach a production cost of **€1.5/W with a 5MW manufacturing plant.**

Such a competitive number can be achieved through the combination of key features of its proprietary technology.

## Material:

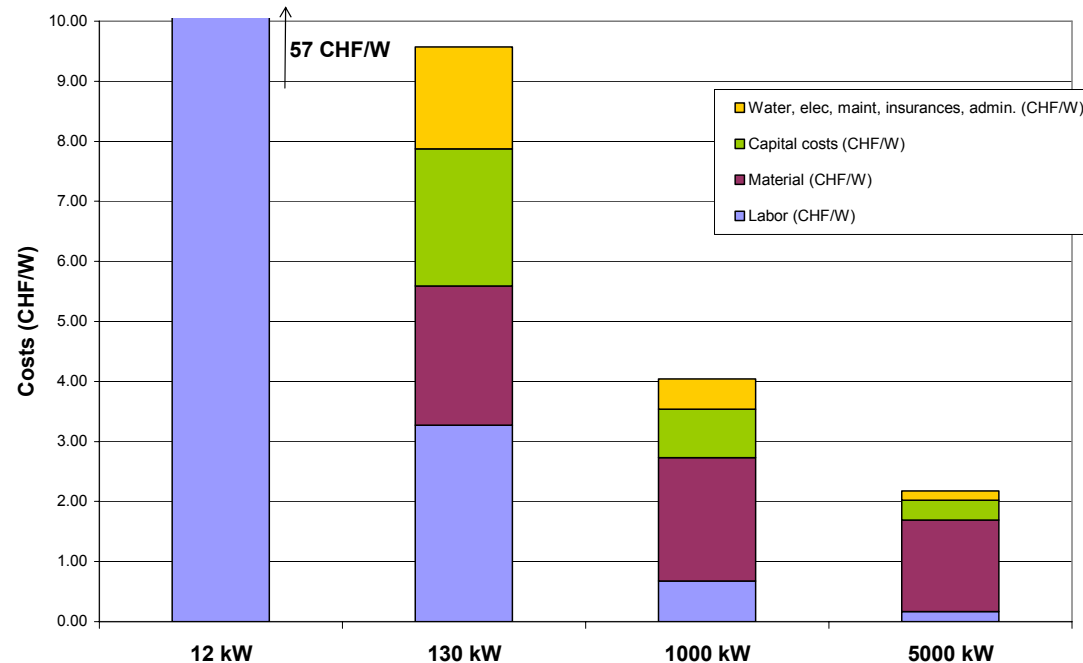
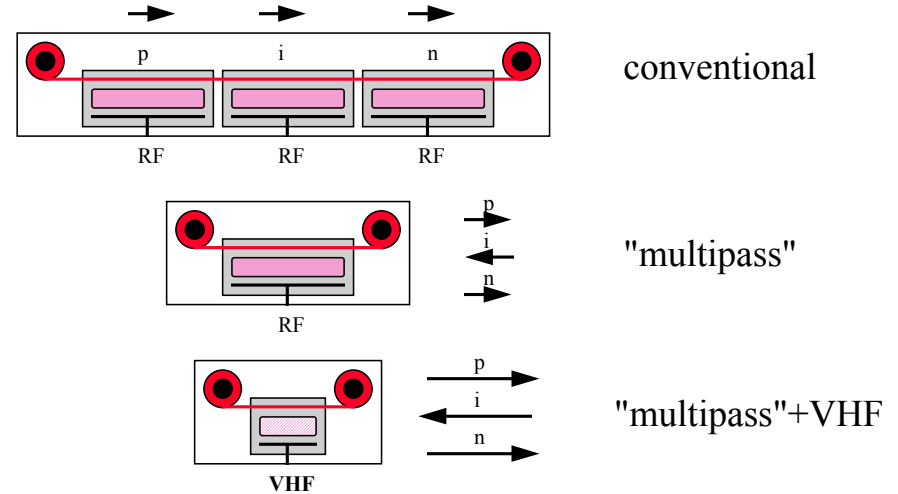
Low cost plastic substrate and encapsulate is used and only one third of a micron of silicon is deposited as an active layer.

## Equipment:

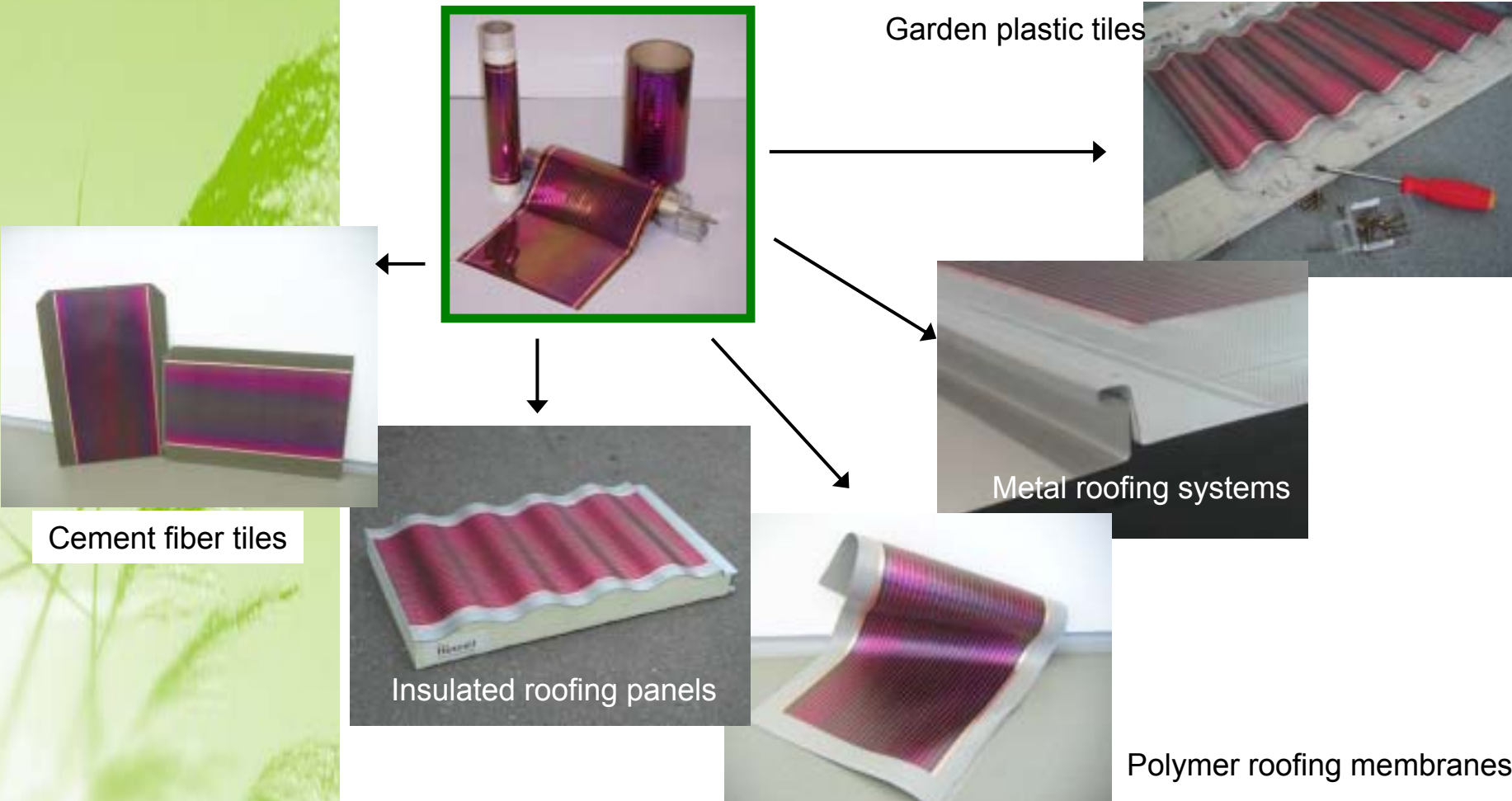
Thanks to its patented multi-pass VHF process, only one plasma chamber is necessary to deposit all the silicon layers.

## Process:

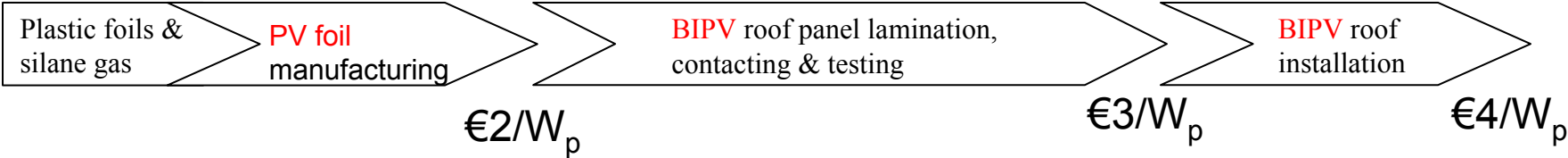
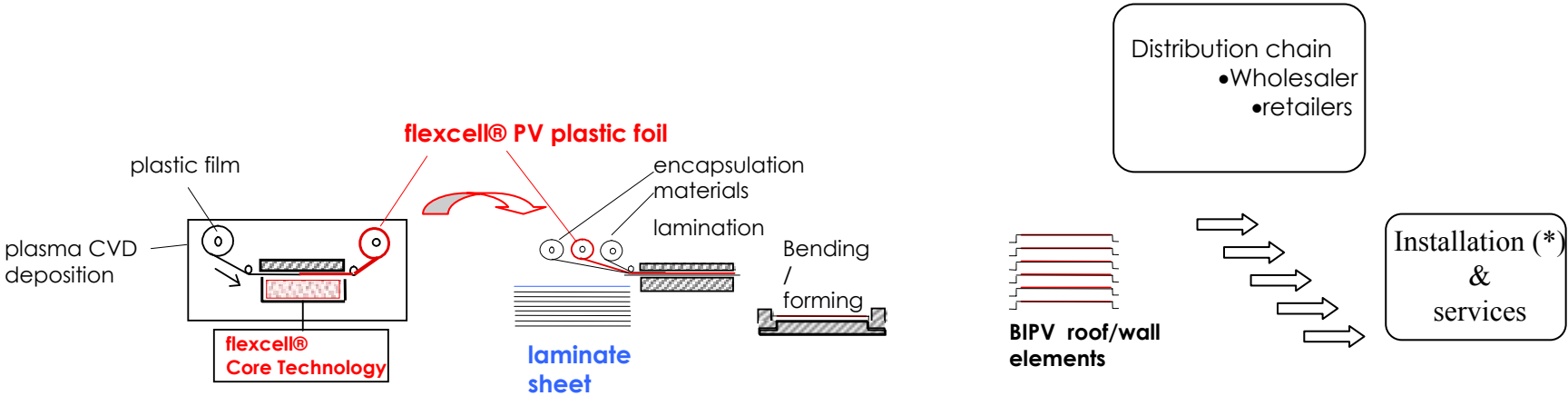
The fully automated roll-to-roll and very high frequency (VHF) process guarantees high throughput and low labor involvement.



# Perspectives long terme (1/3)



**VHF is able to realize the aesthetic merger of photovoltaic modules and building components in a cost effective manner**






Today's best PV system price:

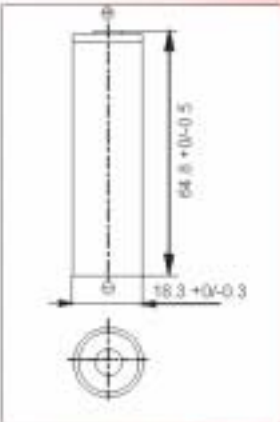
Solar module	€3/W <sub>p</sub>
Sub-structure	€1/W <sub>p</sub>
Inverter & cabling	€1/W <sub>p</sub>
<u>Mounting</u>	<u>€1/W<sub>p</sub></u>
<b>Total</b>	<b>€6/W<sub>p</sub></b>

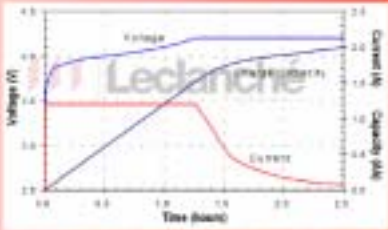
VHF's price forecast:

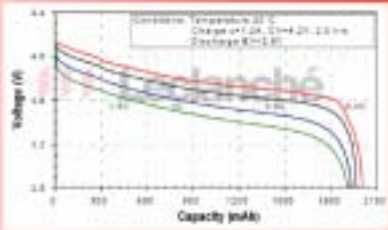
Solar module	€3/W <sub>p</sub>
Sub-structure	€0/W <sub>p</sub>
Inverter & cabling	€1/W <sub>p</sub>
<u>Mounting</u>	<u>€0/W<sub>p</sub></u>
<b>Total</b>	<b>€4/W<sub>p</sub></b>

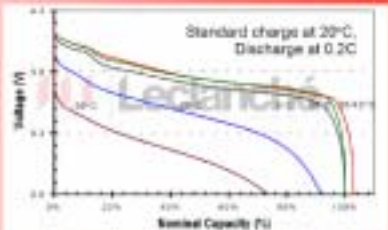


**TECHNICAL SHEET**  
Lithium Ion battery  
**LGC 1865**  
031589006









**Specifications**

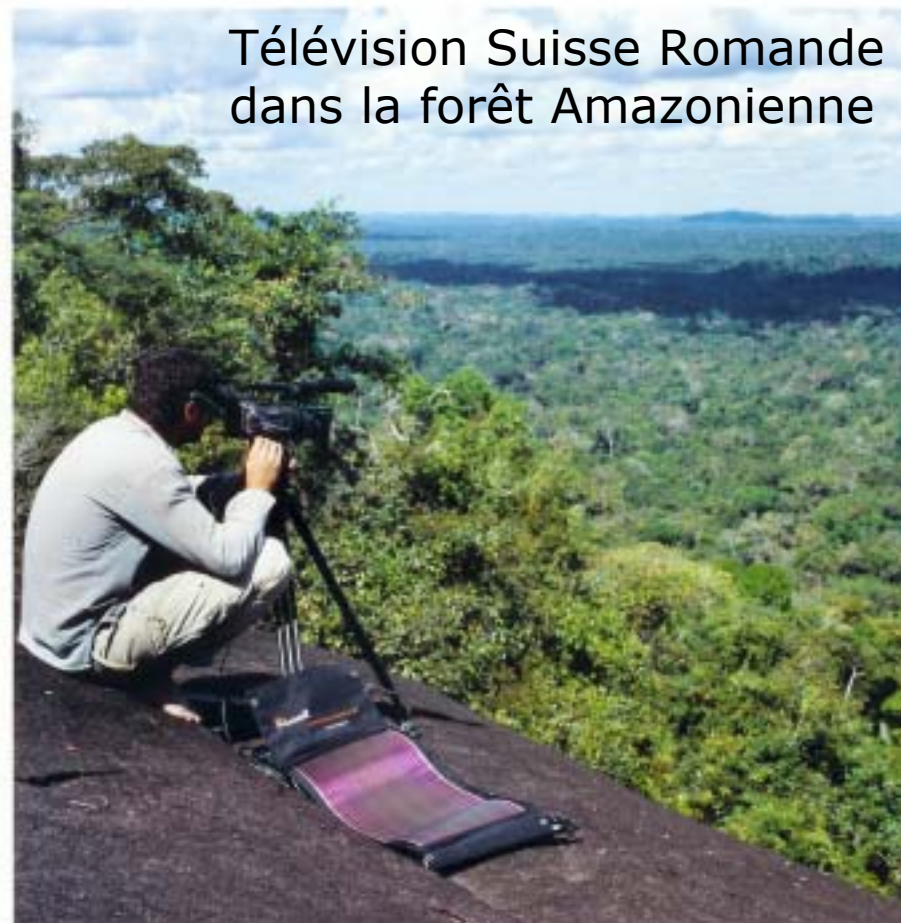
Nominal Voltage	3.7 V
Capacity (mAh)	8.20 (Discharge)
	Minimum 1800 <sup>1</sup>
	Typical 1
Dimensions	Ø 18.3 ± 0.3
	Height 64.6 ± 0.5
Weight 1	47 g
Internal Impedance <sup>2</sup> at 1000 Hz	+ 110 mΩ after charge

1: Nominal capacity, rated at 0.2 C, 25°C  
2: Average capacity. For reference only  
3: weight and internal impedance are for reference

**Charging characteristics**

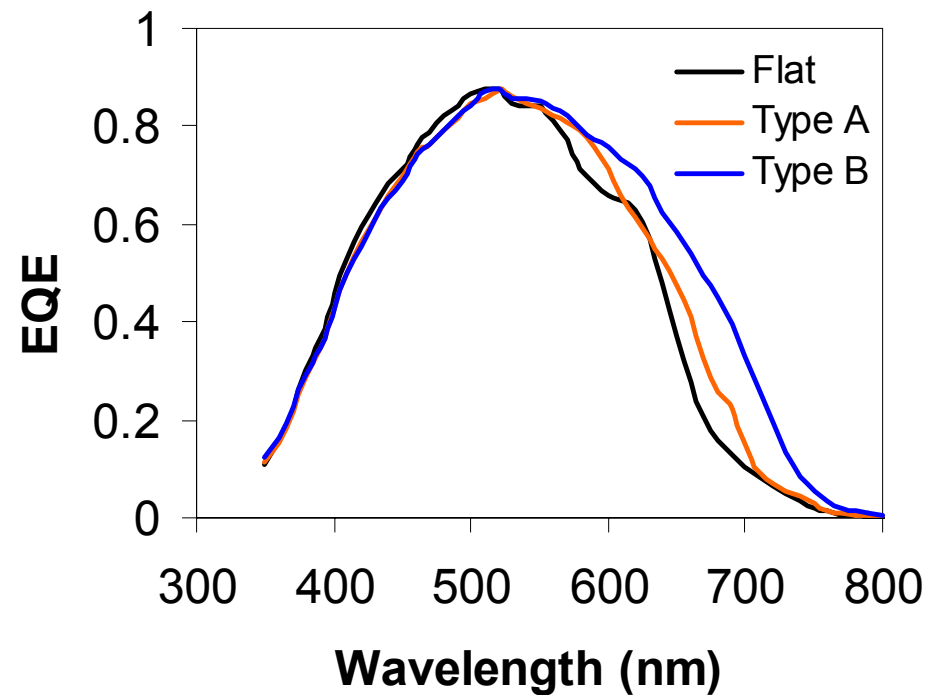
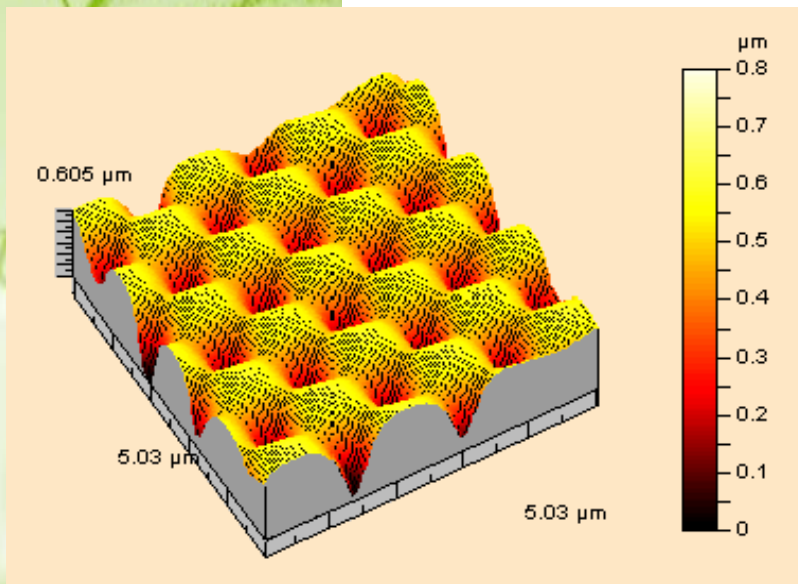
Charge	Standard	1800 mA (0.2 C) for 3 hours	
	Rapid	2000 mA (0.5 C) for 2.5 hours	
Ambient temperature	Charge	Standard	0 to 45
		Rapid	0 to 40
	Discharge		-20 to 55
		Storage	-20 to 45

## Intégration d'un battery-pack Li-ion



Télévision Suisse Romande dans la forêt Amazonienne

7.25% stable performance on textured PET substrate achieved with IMT (Uni Neuchâtel)



Merci de votre attention

