Recent Solar Technologies Developments at FES and NRC: Potential applications in buildings

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26 January 2012

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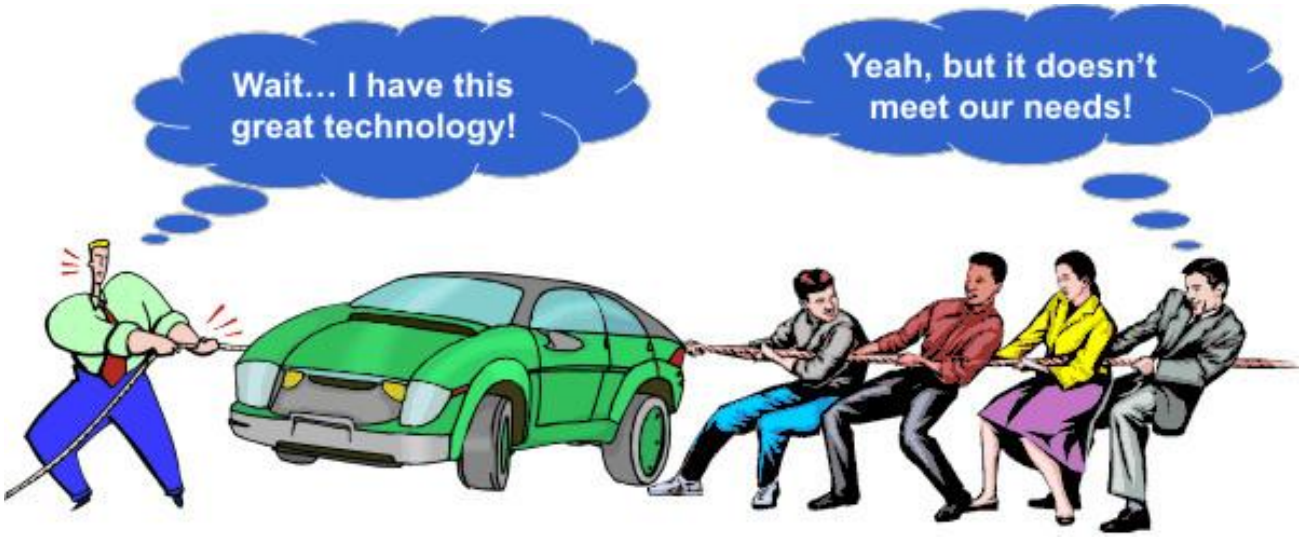
National Research Council Canada | Conseil national de recherches Canada

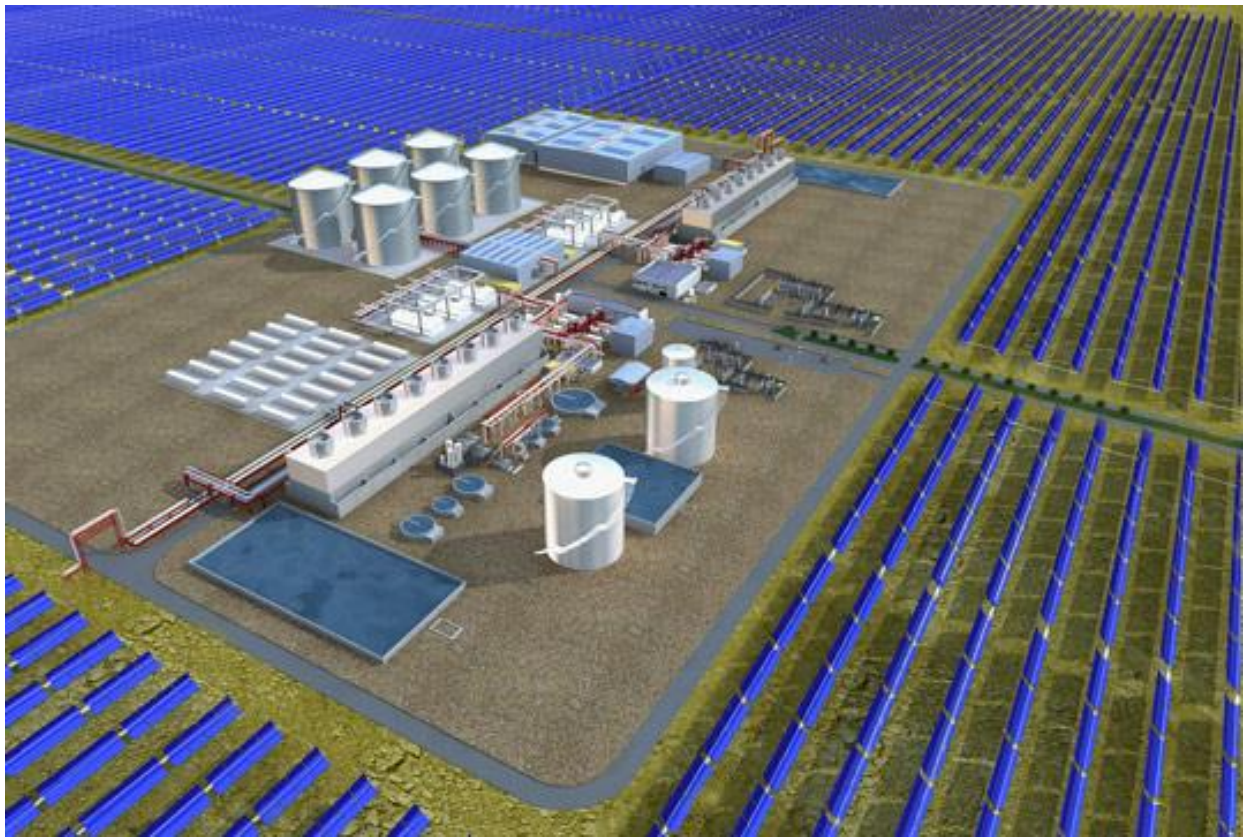
Canada

A different strategy for solar energy is needed!

- Reproducing the fossil fuel strategy
- Technology push vs. market pull
- Must address market/social needs



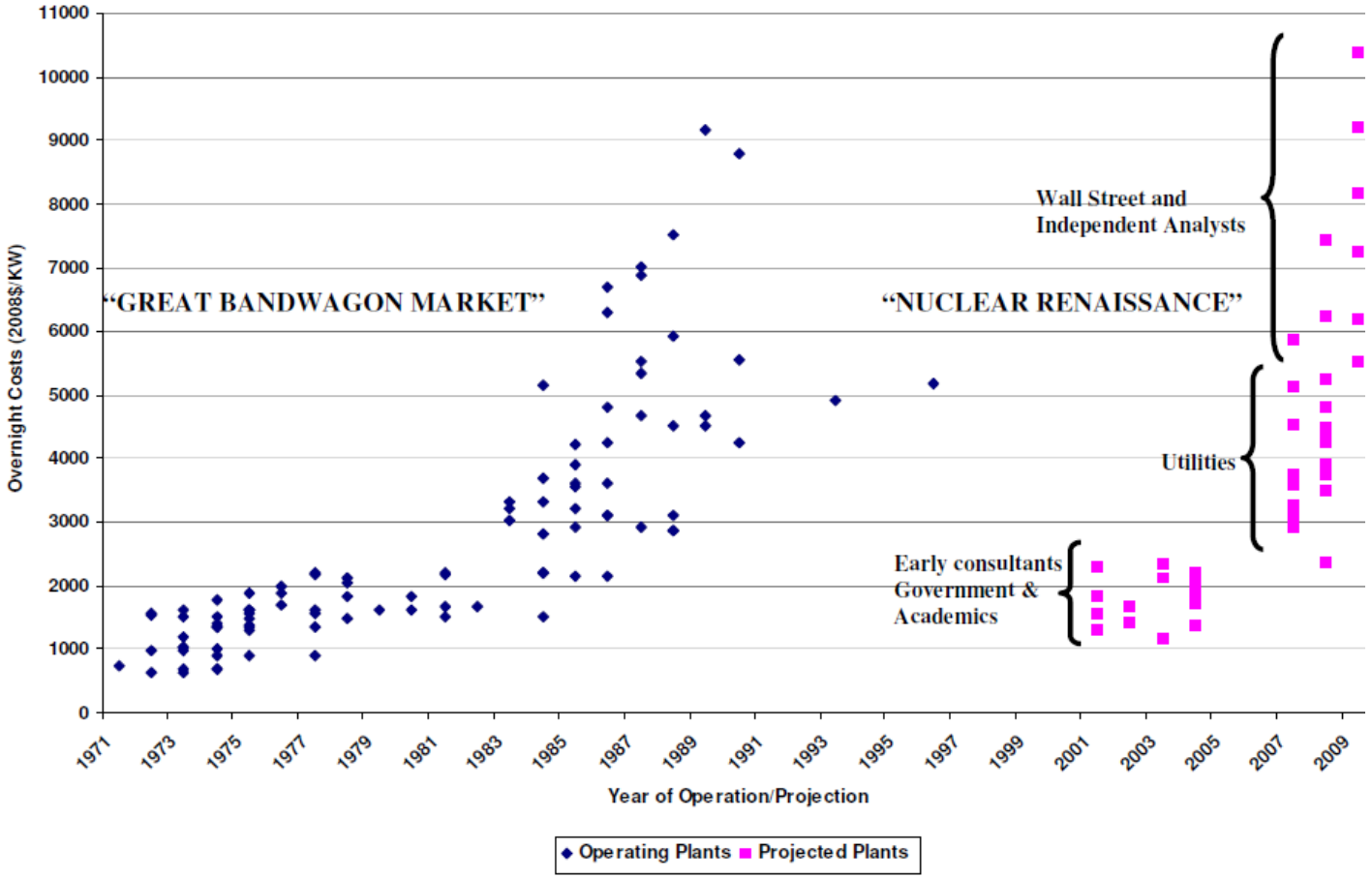
Large scale solar power plant (50-200 MW)



F. Bensebaa, Solar based large scale power plants: what is the best option? *Progress in Photovoltaics 2011*

- O&M > 4%
- First solar power plants: bankrupt!
- Desertec: a big but a bad idea!
- IEA Task-Force 8: energy from the desert
- IRENA?

Capital cost of nuclear power generation



Ref. unknown

Solar-Nuclear kWh cost comparison

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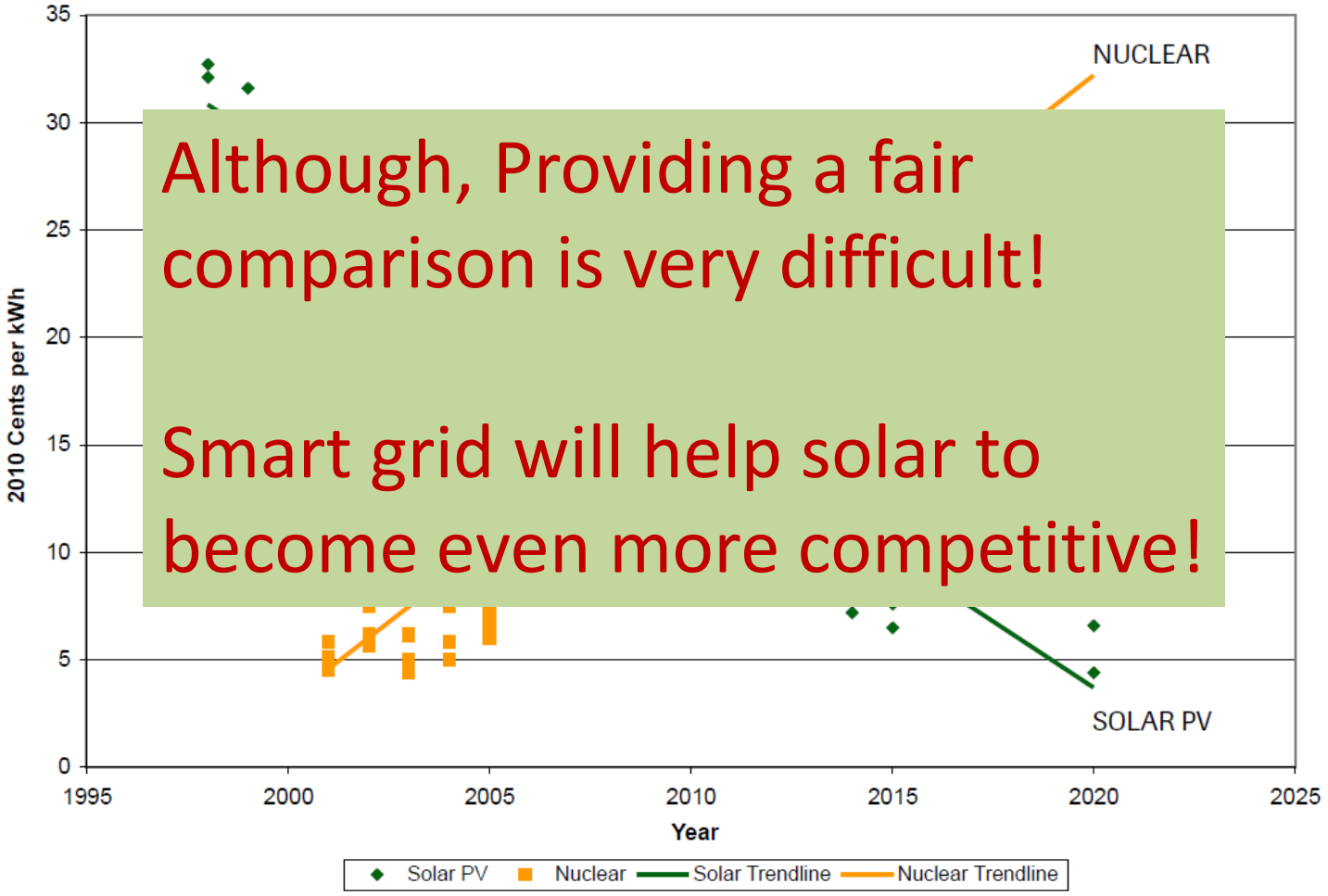
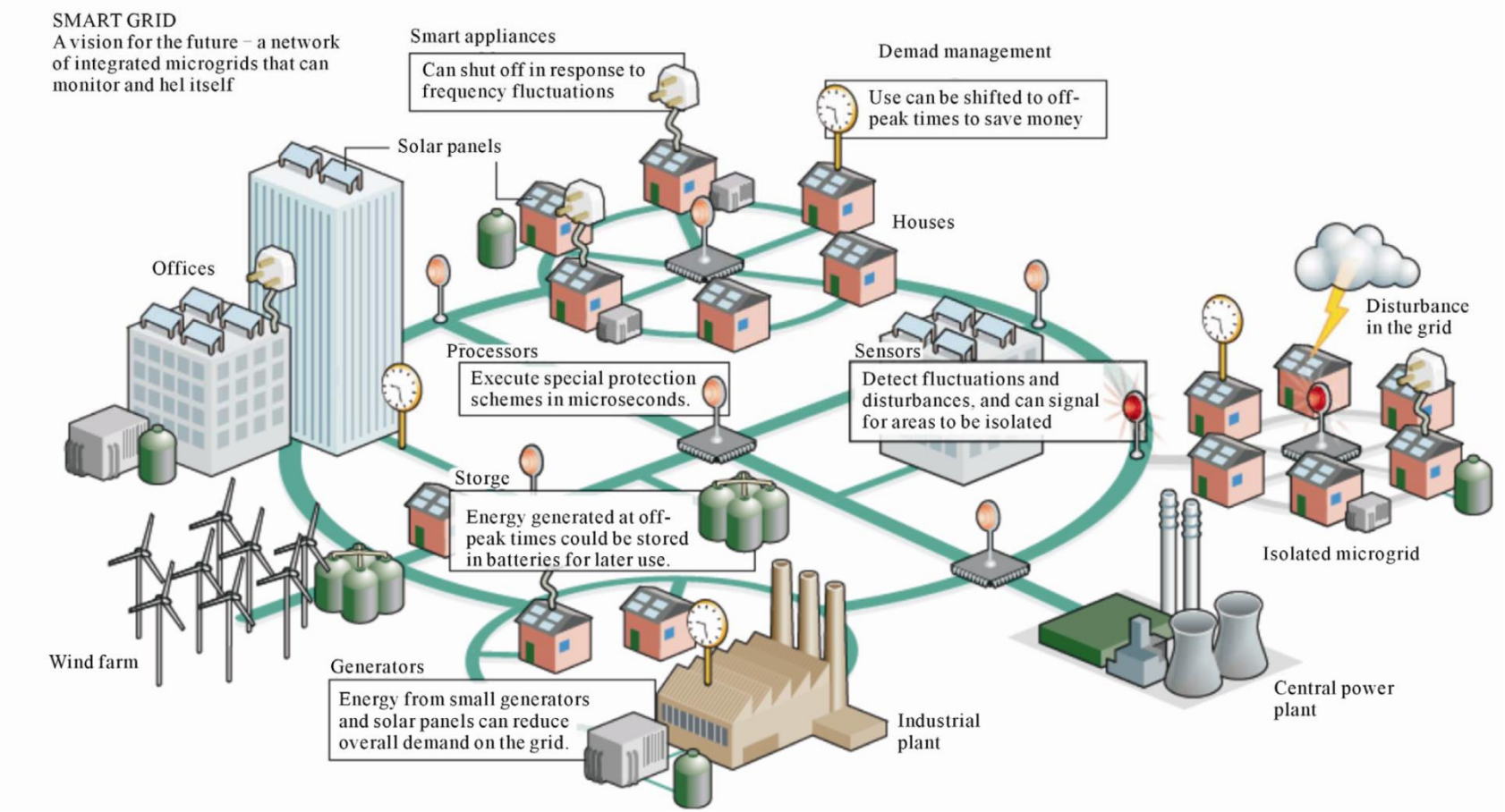
Solar-Nuclear kWh cost comparison



Although, Providing a fair comparison is very difficult!

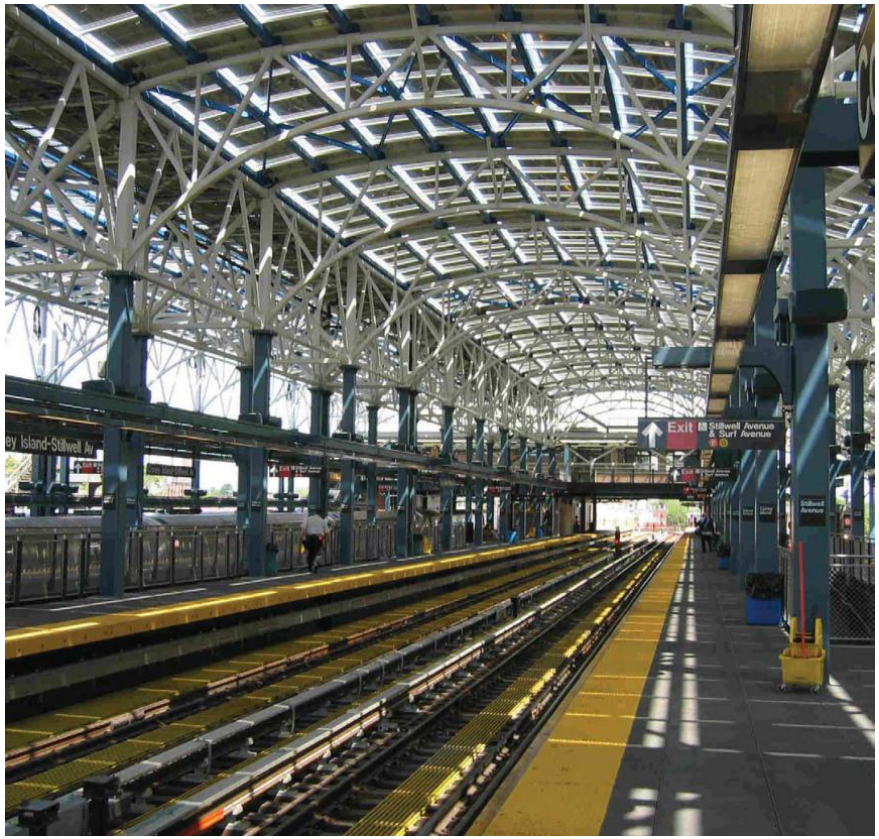
Smart grid will help solar to become even more competitive!

A schematic representation of smart grid network



Smart Grid and Renewable Energy, 2011, 2, 305-311

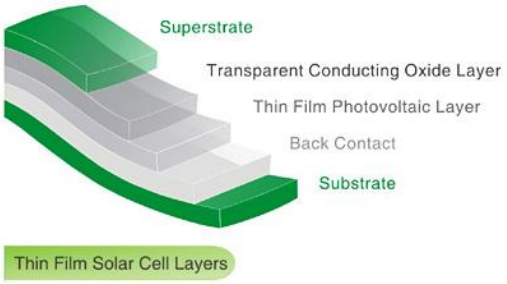
Market needs!

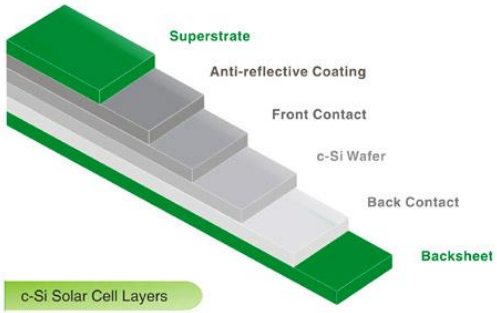


- Glass based modules are heavy, expensive
- Flexible modules (a-Si) have low efficiency.

PV technologies and applications for BIPV

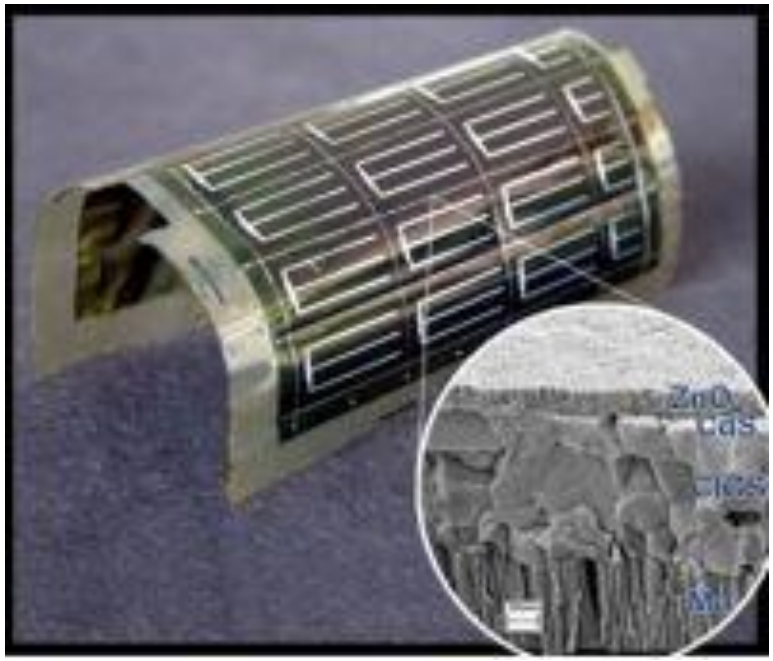
Module and Cell Efficiency							
Technology	Thin Film					Crystalline Silicon	
	(a-Si)	(CdTe)	CI(G)S	a-Si/ µSi	Dye s. cells	Mono	Multi
							
Cell efficiency	4-7%	8-10%	7-11%	6-8%	2-4%	16-22%	14-16%
Module efficiency						13-19%	12-15%
Area Needed per KW (for modules)	~ 15 m²	~ 11m²	~ 10m²	~12m²		~7m²	~8m²





http://www.biosolar.com/products.html#super

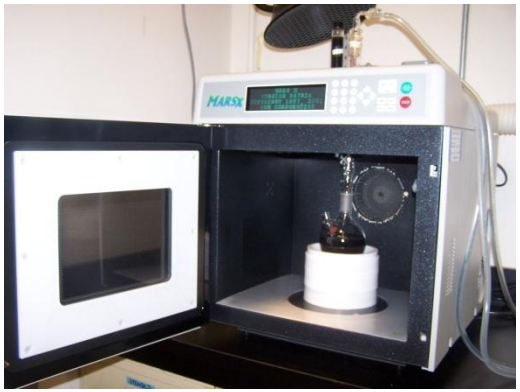
17.6% efficiency flexible CIGS solar cell on plastic



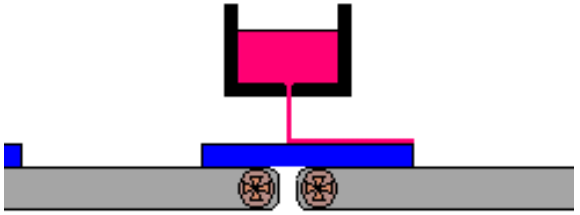
Tiwari's group (EMPA)

NRC technology: Gen. III CIGS

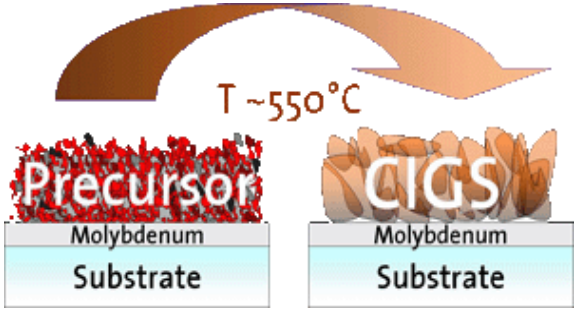
1. Preparation of nano-sized precursor paste



2. Fast printing of 2µm thin precursor film



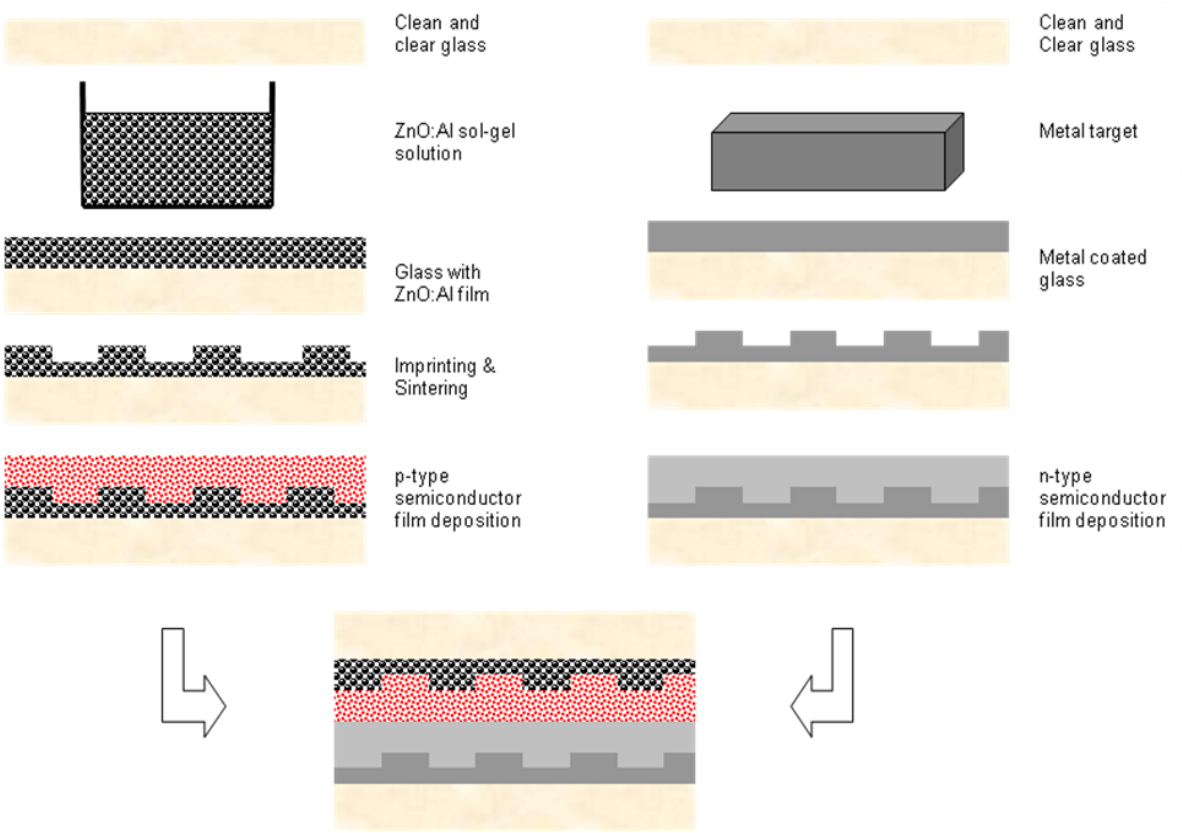
3. Thermal annealing



4. Junction & encapsulation

Green Chemistry Journal 2010 & PCT patent 2007

Non-vacuum process for module assembly



F. Bensebaa, “TRANSPARENT AND/OR PHOTOVOLTAIC SOLAR CELL AND MODULE”, F. Bensebaa Canadian Patent CIPO CA2621665, 19 Feb. 2008

Solar Power Light Post

Patent 61/504,507

For installation on streets, parking lots, highways, parks, etc.

Option 1: Off-grid

- Autonomous (int. batteries)
- Does not require electrical infrastructure

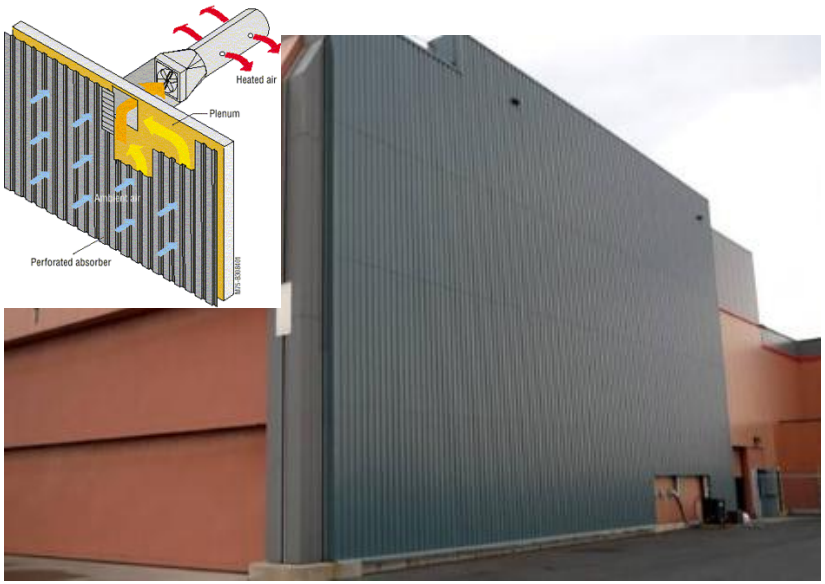
Option 2: Grid-tied

- Distributes power into the grid during daylight hours (inverter)
- Consumes power from the grid during night time

Other platform uses:

- communication (WiFi, GSM)
- cameras
- weather stations
- solar farming

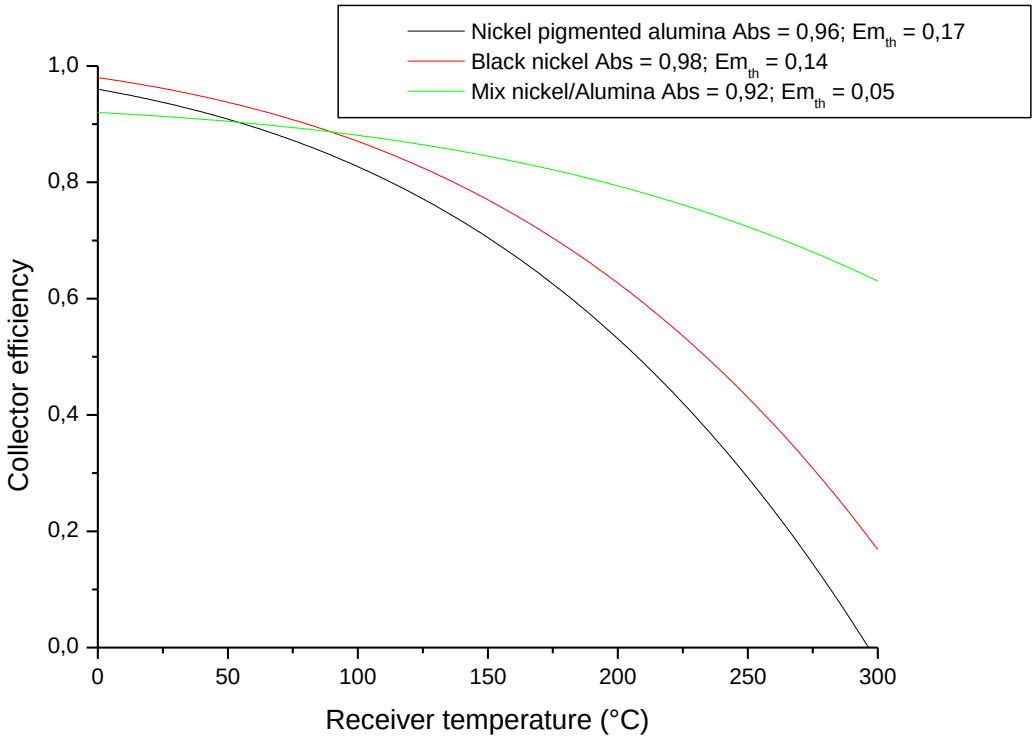
Solar heating (air & water)



•High efficiency is particularly important in low solar radiation regions such as Canada.

• Need for high absorption coefficient using low production cost and operating at intermediary temperature range (200 – 300 ^{o}C).

Efficiency vs. temperature for different coatings



But selective coating tends to degrade at high temperature in air!

Jacque Amory, F. Bensebaa, Jose Etcheverry, FES-NRC Internal Report

Thermal yields and cost comparisons

	Yield (kWh/m2)	Cost (US$/m2)
Unglazed stainless steel absorber	250-300	140-160
Flate-plate collector	350-500	200-350

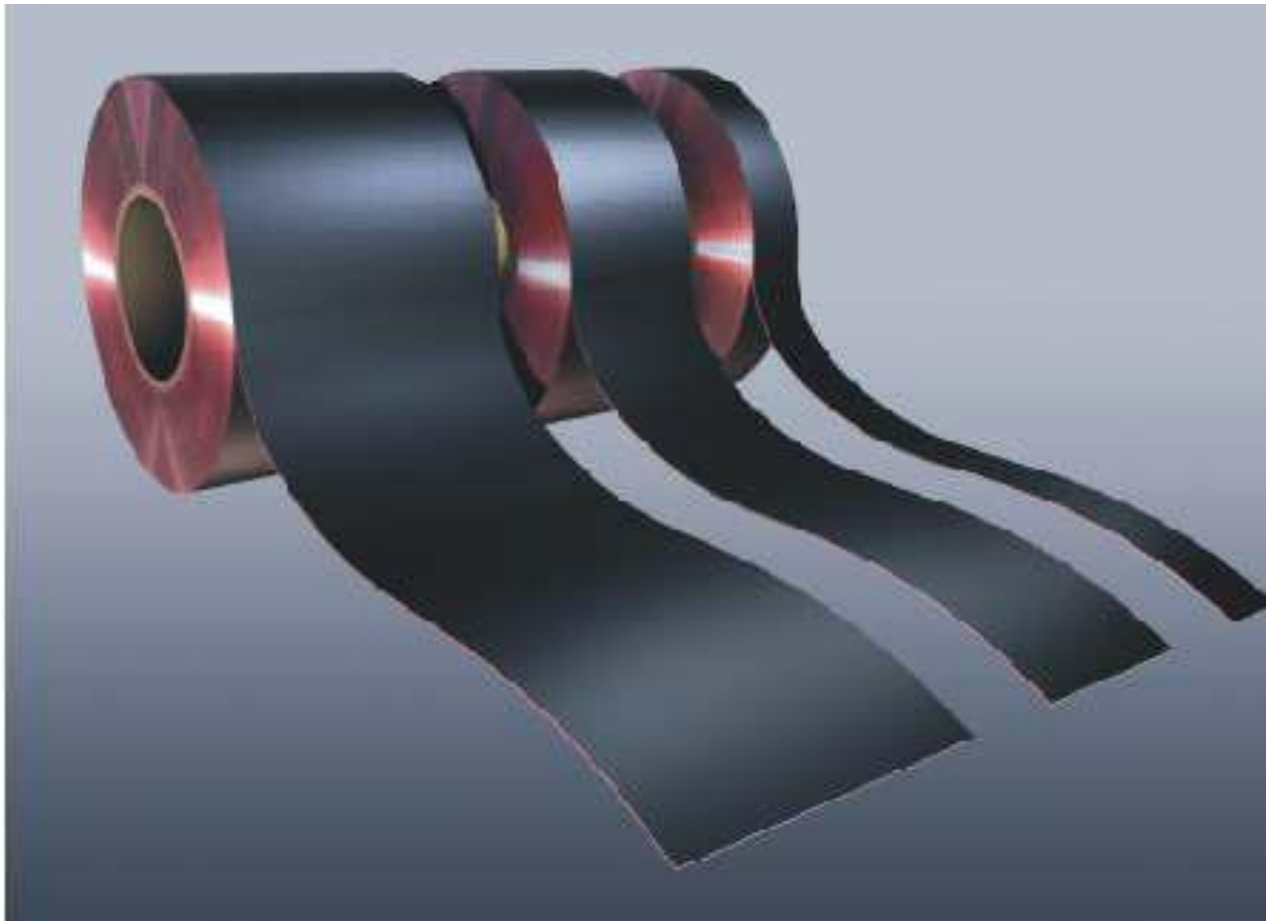
Advantages of the unglazed collector:

1. The absorber can replace the roof skin, saving a zinc sheeting,
2. Suitable for a diversity of roof forms
3. Aesthetic solution for sheet metal roofs.

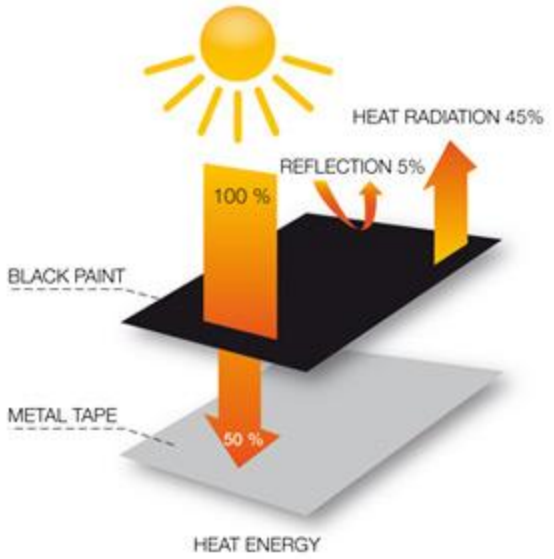
Disadvantages:

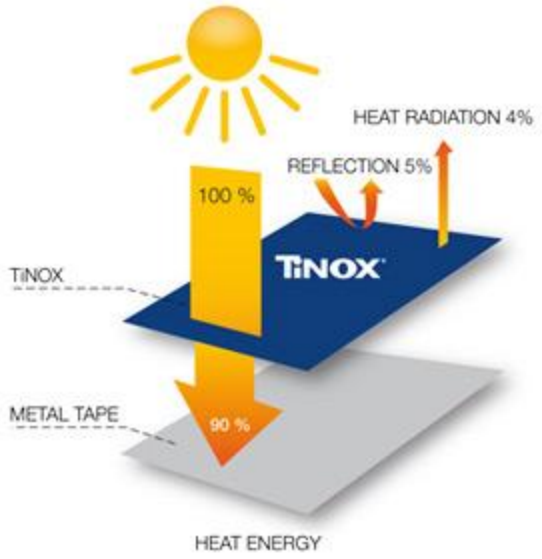
1. Larger surface area is required,
2. Lower energy efficiency.
3. Degradation at higher temperature

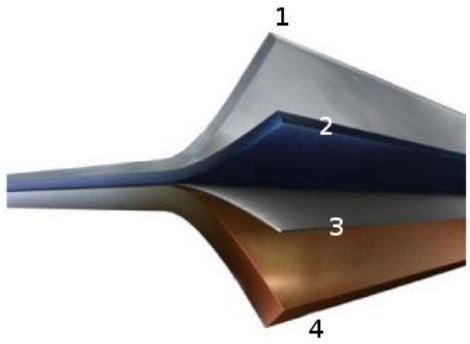
Solar thermal absorber on flexible substrate



TiNOX technology

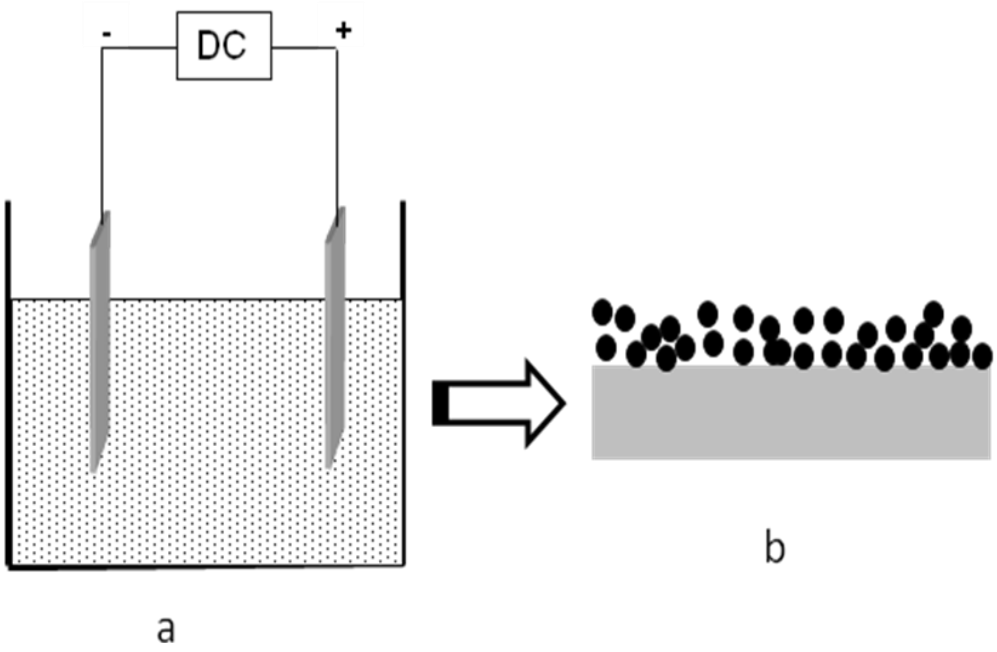


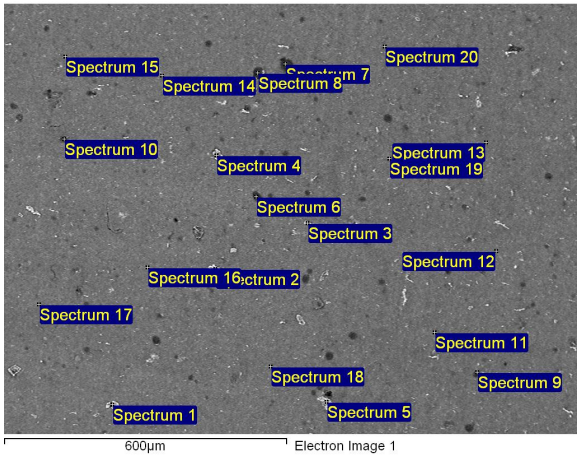




1) Quartz Glass
2) Titanium: Extremely hard, corrosion-resistant
3) Titanium Carbide: This layer acts as a diffusion barrier and adhesion layer.
4) Copper: great IR reflector and highest heat conductivity

Gradient nano-dispersion film: high α/ε



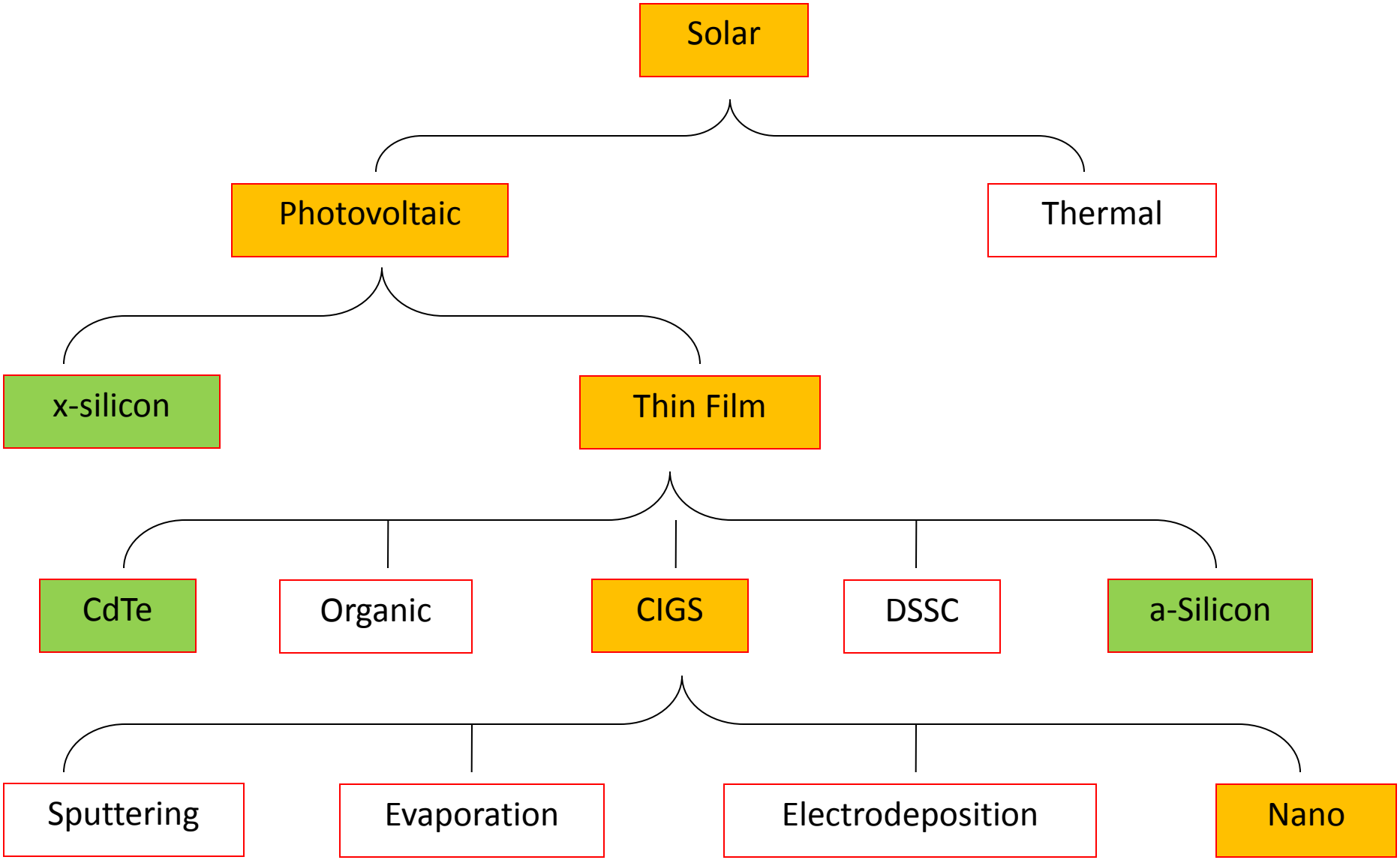


Collaboration with Steve Baksa (Vale-Inco)

Technology solutions for flexible and cost effective solar thin films exist!

Current policies need improvements

Thank-you


Solar
Photovoltaic
Thermal
x-silicon
Thin Film
CdTe
Organic
CIGS
DSSC
a-Silicon
Sputtering
Evaporation
Electrodeposition
Nano