BIPV - Building integrated photo voltaics
Many million project buildings are in dire need of renovation.
Sweden has an ambitious goal of climate neutrality by year 2045.
A cost efficient way of reducing energy use and replacing it with renewable energy is to mount PV modules as roof and facade material while windows are replaced and insulation is added.
The entire building stock could generate more electricity than it consumes!
Step-by-step deep retrofit and building integrated facade+roof on a ‘miljonprogramhus’
Monthly average production

The graph shows the monthly average production in kWh from January to December. The following data is represented:
- **Total building consumption**
- **Total roof PV production**
- **Total facade PV production**

The data indicates variations in energy production and consumption throughout the year, with peaks and troughs that correlate with seasonal changes.
Avoiding thermal bridges - window installation

\[ \theta_{\text{si min}} = 15,00 \, ^\circ \text{C} \]
\[ f_{\text{Rsi}} = 0.833 \]
\[ \varphi_{\text{Sat50\%}} = 69\% \]
\[ \varphi_{100\%} = 73\% \]
\[ \varphi_{80\%} = 58\% \]

\[ \Psi(\text{install}) = 0.016 \, \text{W/(m}^*\text{K)} \]
Cash flow
Results - heat
Thanks to!

Kollektivhuset Stacken
Passivhusbyrån
Helhetshus Arkitektstudio
Naturskyddsföreningen
Västra Götalandsregionen
Energimyndigheten
Investment (roughly)

- a-Si
- mono-Si
- Facade panel
- Tiles

Mounting €/m² | Material €/m²
Present value of future electricity (0.1 €/kWh, 20 years, 6% discounting rate)

- South facade
- South roof
- North facade
- North roof

- a-Si, €/m²
- mono-Si, €/m²
## Solcellsteknologier

<table>
<thead>
<tr>
<th></th>
<th>Rare Minerals</th>
<th>Heavy metals</th>
<th>Efficiency</th>
<th>Cost</th>
<th>EROI</th>
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<tbody>
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<td>mono-Si</td>
<td>+</td>
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Conventional roof cover + PV modules, in total 42 kg/m²:

- Wood 3 kg/m² (battens)
- Concrete: 35 kg/m² (tiles)
- Glass 8 kg/m² (PV module, single glass)
- Aluminium: 2,5 kg/m² (PV module frame and mounting system)
- Steel: 1,5 kg/m² (fasteners)

BIPV roof, in total 19.5 kg/m²:

- Wood 3 kg/m² (battens)
- Glass: 16 kg/m² (PV module double glass)
- Aluminium: 0,3 kg/m² (can be replaced with acetylated wood)
- EPDM-rubber: 0,2 kg/m²
Kappenvägen, Vänersborg

208 (small) a-Si modules, annual production ~7000
Bladvägen, Vänersborg

110 a-Si modules, annual production ~6500 kWh
TechFarm - co-working / co-living, Täby

~400 st mono-Si and ~1500 st a-Si modules, annual production ~150,000
Tångeröds ekoby - Tjörn

In total 189 mono-Si modules, annual production ~45,000
Baskemölla ekoby, Österlen

20 st mono-Si modules, annual production ~5000