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# KIER

## Friday energy letter

# 태양전지 기술 로드맵

KIER 한국에너지기술연구원
KOREA INSTITUTE OF ENERGY RESEARCH

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## 태양전지 기술 로드맵

2010. 6. 11

*** 출처 : 'Technology Roadmap - Solar photovoltaic energy' - IEA (2010)**

### 1. 핵심 시사점

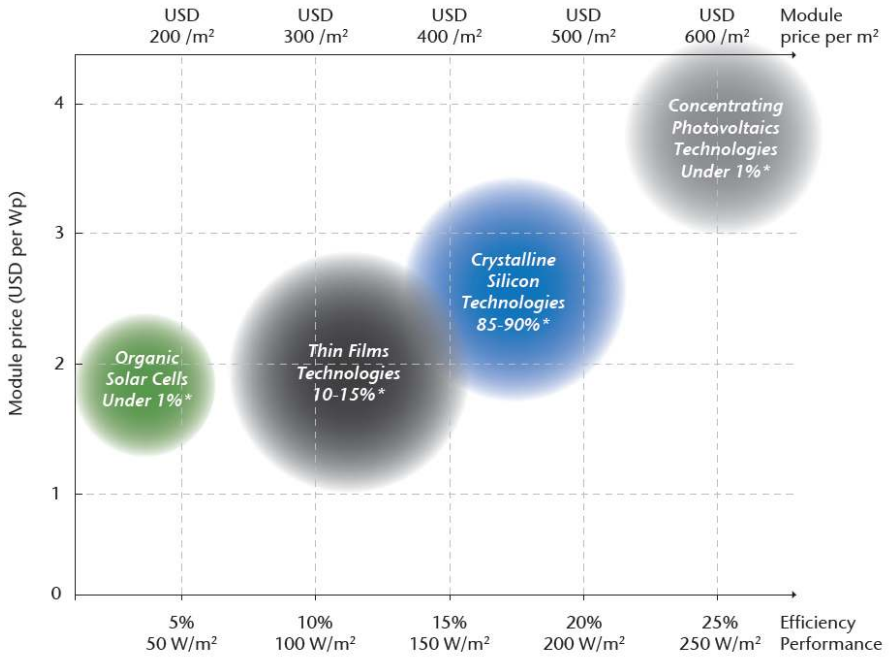
○ 태양전지기술은 이미 상업적으로 이용가능하며, 장기 성장 가능성이 높은 신뢰성 있는 기술로서, 본 로드맵에서는 2050년까지 전세계 발전량 11%를 차지하며, 이를 통하여 연간 2.3Gt-$CO_2$를 감축할 수 있을 것으로 전망함.

○ 태양전지 기술은 2020년 많은 지역에서 기존 발전기술에 대한 경쟁력(Competitive Parity)를 확보할 수 있을 것이며, 이에 따라 보조금 지급이 필요없는 자생적으로 지속가능한 시장을 형성하는 방향으로 정책이 선회되어야 하나, 지속적인 연구개발은 여전히 필요함.

○ 태양전지 기술이 성숙함에 따라, 그리드 통합 및 관리 기술과 에너지저장 기술이 핵심 이슈가 될 것임.

○ 향후 학습효과의 가속화와 불필요한 중복 투자의 방지를 위하여 국가간 공동 연구 및 보급의 확대가 필요함.

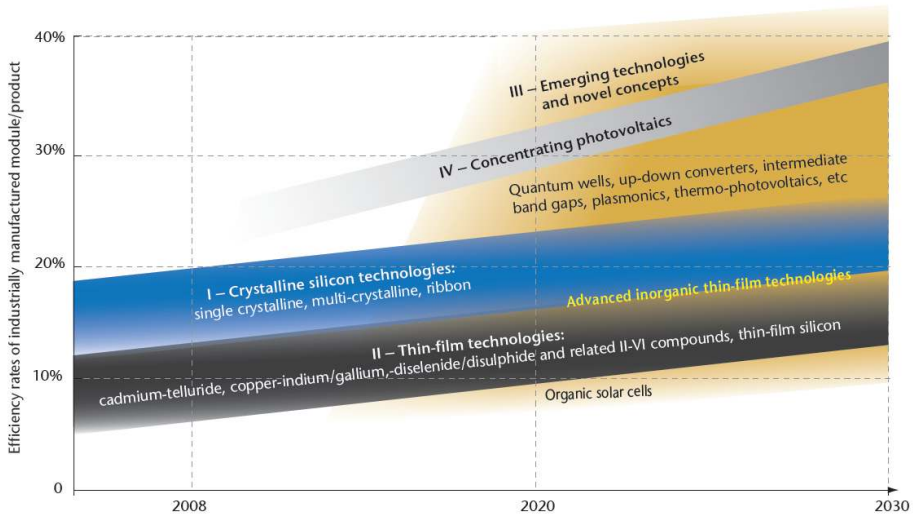
### 2. PV 기술현황




** percentage share of 2008 market*

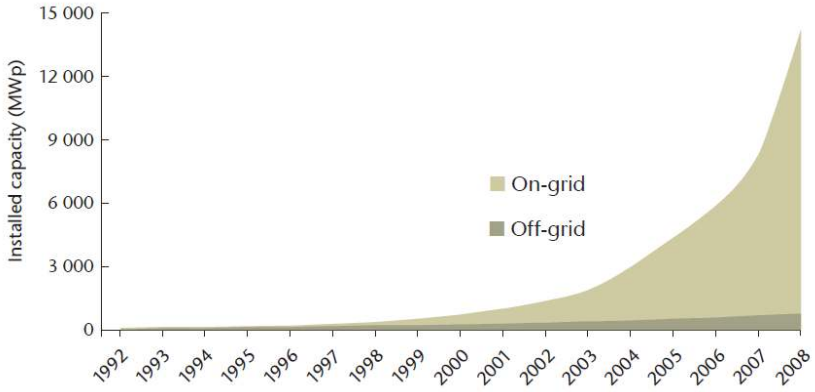
| Wafer-based c-Si | | Thin films | | |
|---|---|---|---|---|
| sc-Si | mc-Si | a-Si; a-Si/µc-Si | CdTe | CIS/CIGS |
| 14-20% | 13-15% | 6-9% | 9-11% | 10-12% |

<그림 1> 태양전지 모듈별 성능 및 가격 현황



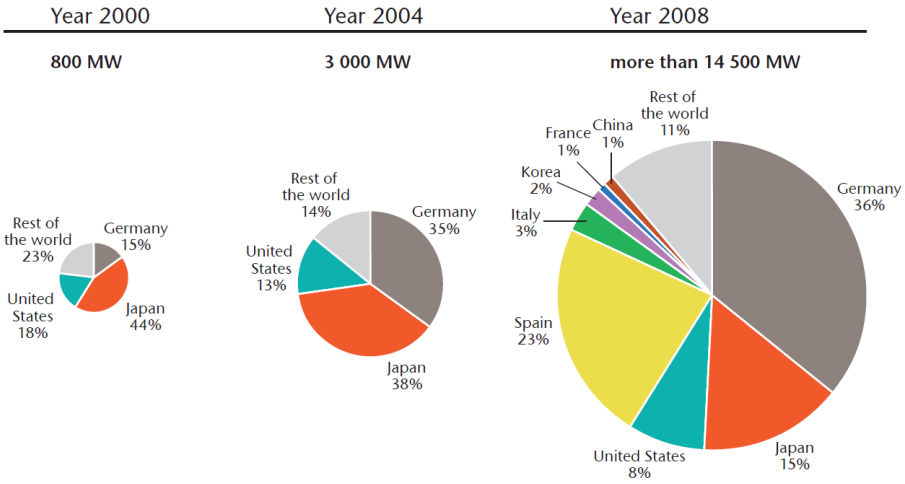

<그림 2> PV 기술 현황 및 전망

### 3. PV 시장현황 및 전망

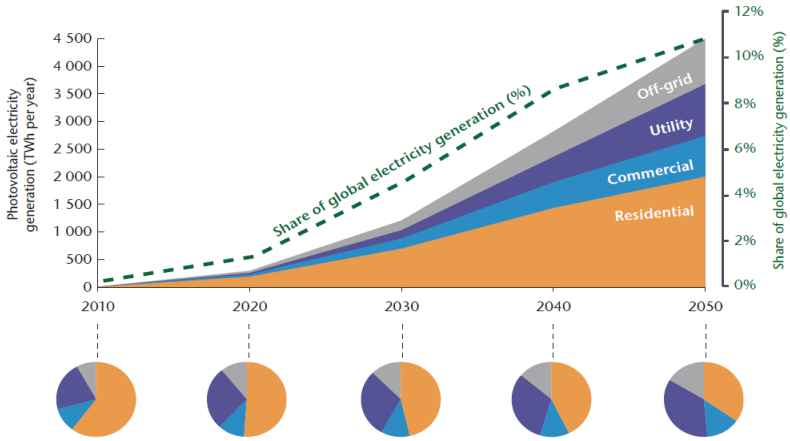



<그림 3> 전 세계 누적 PV 보급량

(자료출처: IEA PVPS for those IEA PVPS countries reporting data; estimates for other countries.)

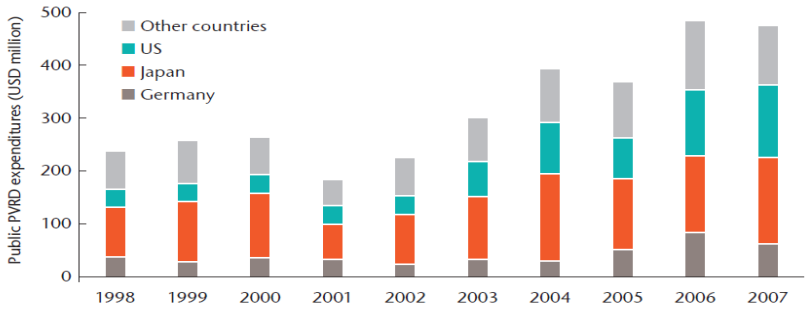



<그림 4> 연도별 PV시장의 선도국가 현황




<그림 5> 수요부문별 PV 보급 전망

## 4. PV 연구개발 동향




<그림 6> 각국 PV R&D 규모 (자료출처: IEA PVPS)

[표 1] 수요부문별 가격 목표

<table>
<tr><th>수요부문</th><th>가격 목표</th></tr>
<tr><td>Residential</td><td>
<table>
<tr><th></th><th></th><th>2008</th><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td colspan="2">Typical turn-key system price (2008 USD/kW)</td><td>6000</td><td>2700</td><td>1800</td><td>1200</td></tr>
<tr><td rowspan="3">Typical electricity generation costs (2008 USD/MWh)*</td><td>2000 kWh/kW</td><td>360</td><td>160</td><td>100</td><td>65</td></tr>
<tr><td>1500 kWh/kW</td><td>480</td><td>210</td><td>135</td><td>90</td></tr>
<tr><td>1000 kWh/kW</td><td>720</td><td>315</td><td>205</td><td>135</td></tr>
</table>
Assumptions: Interest rate 10%, technical lifetime 25 years (2008), 30 years (2020), 35 years (2030) and 40 years (2050); operations and maintenance (O&M) costs 1%.
</td></tr>
<tr><td>Commercial</td><td>
<table>
<tr><th></th><th></th><th>2008</th><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td colspan="2">Typical turn-key system price (2008 USD/kWp)</td><td>5000</td><td>2250</td><td>1500</td><td>1000</td></tr>
<tr><td rowspan="3">Typical electricity generation costs (2008 USD/MWh)*</td><td>2000 kWh/kWp</td><td>300</td><td>130</td><td>85</td><td>55</td></tr>
<tr><td>1500 kWh/kWp</td><td>400</td><td>175</td><td>115</td><td>75</td></tr>
<tr><td>1000 kWh/kWp</td><td>600</td><td>260</td><td>170</td><td>110</td></tr>
</table>
Assumptions: Interest rate 10%, technical lifetime 25 years (2008), 30 years (2020), 35 years (2030) and 40 years (2050); O&M costs 1%.
</td></tr>
<tr><td>Utility</td><td>
<table>
<tr><th></th><th></th><th>2008</th><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td colspan="2">Typical turn-key system price (2008 USD/kWp)</td><td>4000</td><td>1800</td><td>1200</td><td>800</td></tr>
<tr><td rowspan="3">Typical electricity generation costs (2008 USD/MWh)*</td><td>2000 kWh/kWp</td><td>240</td><td>105</td><td>70</td><td>45</td></tr>
<tr><td>1500 kWh/kWp</td><td>320</td><td>140</td><td>90</td><td>60</td></tr>
<tr><td>1000 kWh/kWp</td><td>480</td><td>210</td><td>135</td><td>90</td></tr>
</table>
Assumptions: Interest rate 10%, technical lifetime 25 years (2008), 30 years (2020), 35 years (2030) and 40 years (2050); O&M costs 1%.
</td></tr>
</table>

[표 2] 실리콘 태양전지의 기술적 목표 및 핵심 기술개발 이슈

| Crystalline silicon technologies | 2010 – 2015 | 2015 – 2020 | 2020 – 2030 / 2050 |
|---|---|---|---|
| **Efficiency targets in % (commercial modules)** | • Single-crystalline: 21%<br>• Multi-crystalline: 17% | • Single-crystalline: 23%<br>• Multi-crystalline: 19% | • Single-crystalline: 25%<br>• Multi-crystalline: 21% |
| **Industry manufacturing aspects** | • Si consumption < 5 grams / Watt (g/W) | • Si consumption < 3 g/W | • Si consumption < 2 g/W |
| **Selected R&D areas** | • New silicon materials and processing<br>• Cell contacts, emitters and passivation | • Improved device structures<br>• Productivity and cost optimisation in production | • Wafer equivalent technologies<br>• New device structures with novel concepts |

[표 3] 박막 태양전지의 기술적 목표 및 핵심 기술개발 이슈

| Thin film technologies | 2010 – 2015 | 2015 – 2020 | 2020 – 2030 |
|---|---|---|---|
| **Efficiency targets in % (commercial modules)** | • Thin film Si: 10%<br>• Copper indium gallium (di)selenide (CIGS): 14%<br>• Cadmium-telluride (CdTe): 12% | • Thin film Si: 12%<br>• CIGS: 15%<br>• CdTe: 14% | • Thin film Si: 15%<br>• CIGS: 18%<br>• CdTe: 15% |
| **Industry manufacturing aspects** | • High rate deposition<br>• Roll-to-roll manufacturing<br>• Packaging | • Simplified production processes<br>• Low cost packaging<br>• Management of toxic materials | • Large high-efficiency production units<br>• Availability of manufacturing materials<br>• Recycling of modules |
| **Selected R&D areas** | • Large area deposition processes<br>• Improved substrates and transparent conductive oxides | • Improved cell structures<br>• Improved deposition techniques | • Advanced materials and concepts |

[표 4] 집광형 태양전지 등 차세대 기술 전망 핵심 기술개발 이슈

| | Concentrating PV | Emerging technologies | Novel technologies |
|---|---|---|---|
| **Type of cell** | High cost, super high efficiency | Low cost, moderate performance | Very high efficiency<br>Full spectrum utilisaton |
| **Status and potential** | 23% alternating-current (AC) system efficiency demonstrated<br>Potential to reach over 30% in the medium-term | Emerging technologies at demonstration level (*e.g.* polymer PV, dye PV, printed CIGS)<br>First applications expected in niche market applications | Wide variety of new conversion principle and device concepts at lab level<br>Family of potential breakthrough technologies |
| **Selected R&D areas** | Reach super high efficiency over 45%<br>Achieve low cost, high-performance solutions for optical concentration and tracking | Improvement of efficiency and stability to the level needed for first commercial applications<br>Encapsulation of organic-based concepts | Proof-of-principle of new conversion concepts<br>Processing, characterisation and modelling of especially nano-structured materials and devices |

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