PV Market & Industry Development

From self-consumption to 100% RES, a paradigm shift for PV

Ir Gaëtan Masson
Director, Becquerel Institute
Content & Strategy, Solar United
Vice-Chairman, EU PV Technology & Innovation Platform
Operating Agent, IEA-PVPS Task 1
• Research oriented Institute and consulting company for Solar Technologies.

• Global PV Market Analysis including competitiveness and economics.

• Industry analysis together with quality & reliability.

• Integration into electricity systems (grids and markets).

• In-house experts / Global network of experts and stakeholders

• PV Market Alliance partner
What is IEA PVPS?

• Implementing Agreement from International Energy Agency – Technology Collaboration Program

• Established in 1993
• 29 members: 24 countries, European Commission, 4 associations

• Strategy 2013-2017: “To enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems”
- PV market development
- PV prices and technology
- Competitive PV tenders
- PV competitiveness
- 100% RES
- Self-consumption
1. Market Development
FROM 1.1 TO 50 GW IN 11 YEARS

51 GW
228 GW

Source: IEA-PVPS 2015
CONFIDENCE IN NUMBERS?

- From 50 to 59 GW installed in 2015
- Who’s right, who’s wrong?
- Counting apples, pears... and more?
- Some rules
  - Counting AC numbers is simply wrong → switch to DC or count both.
  - What does « installed » means? Commissioned?
  - Production > shipments > installations ...
  - ...

Solar United – UNSW October 2016
Becquerel Institute
# TOP 10 INSTALLATIONS AND TOTALS

## Table 1: Top 10 Countries for Installations and Total Installed Capacity in 2015

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Annual Installed Capacity (GW)</th>
<th>Cumulative Installed Capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>15.2</td>
<td>43.5</td>
</tr>
<tr>
<td>2</td>
<td>Japan</td>
<td>11</td>
<td>39.7</td>
</tr>
<tr>
<td>3</td>
<td>USA</td>
<td>7.3</td>
<td>34.4</td>
</tr>
<tr>
<td>4</td>
<td>UK</td>
<td>3.5</td>
<td>25.6</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>2</td>
<td>18.9</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>1.5</td>
<td>8.8</td>
</tr>
<tr>
<td>7</td>
<td>Korea</td>
<td>1</td>
<td>6.6</td>
</tr>
<tr>
<td>8</td>
<td>Australia</td>
<td>0.9</td>
<td>5.4</td>
</tr>
<tr>
<td>9</td>
<td>France</td>
<td>0.9</td>
<td>5.1</td>
</tr>
<tr>
<td>10</td>
<td>Canada</td>
<td>0.6</td>
<td>5</td>
</tr>
</tbody>
</table>
ENERGY VS POWER

Figure 4: National PV penetration in % of the electricity demand based on 2015 capacities.
TOP 1 TO 10 MARKETS

FIGURE 6: EVOLUTION OF MARKET SHARE OF TOP COUNTRIES

SOURCE: IEA PVPS & OTHERS.
PROSPECTS FOR DEVELOPMENT

« The Policy Triangle »

Source: PV Market Alliance – Becquerel Institute 2016
5 YEARS FORECASTS?

- Many countries haven’t stepped in the PV market in a sustainable way (see China, Japan or the US)
- Those that have (Europe) are experiencing difficulties.
- Tenders that are popping up are by definition policy-driven: policy stops, the PV market stops
- Self-consumption is difficult to implement (see China, Italy...)
- Uncertainties reflect, not the intrinsic PV potential but the difficulties to realize that potential.
A TALE OF 2 MARKETS

Distributed PV

Self-consumption, energy efficiency, grid parity, competition with utilities

Prosumers

Centralized PV

Producers

Grid injection, PPA, competition with utilities generation business

One technology
FIGURE 7: SHARE OF GRID-CONNECTED AND OFF-GRID INSTALLATIONS 2000-2015
WHAT KIND OF MARKET AHEAD?

ANNUAL GLOBAL MARKET SEGMENTATION FORECAST 2016 - 2020

Source: PV Market Alliance – Becquerel Institute 2015
SHARE PER REGION

**FIGURE 11:** SHARE OF GRID-CONNECTED CENTRALIZED & DECENTRALIZED PV INSTALLATIONS BY REGION IN 2015

- **The Americas**
- **Europe**
- **Middle East & Africa**
- **Asia Pacific**

SOURCE: IEA PVPS & OTHERS.
MARKET INCENTIVES

**Figure 12:** 2015 Market Incentives and Enablers

- Competitive PPA, 1.1%
- Feed-in Tariff through Tender, 5.6%
- Incentivized Self-Consumption or Net-Metering, 14.9%
- Non-Incentivized Self-Consumption, 0.2%
- Direct Subsidies or Tax Breaks, 16.2%
- Trading of Green Certificates or Similar RPS-Based Schemes, 2.4%
- Feed-in Tariff (for the Entire Production), 59.7%

*Source: IEA, PVPS & Others*
2. Prices and Technology

HELP! I'VE FALLEN AND I CAN'T GET UP
THE CSI LEARNING CURVE

Source: ITRPV 7th Edition - 2016
CRYSTAL BALL ANALYSIS?

- The Learning curve concept is an empirical way of looking at COSTS decrease (due to technology improvements).
- Has been theorized for semi-conductors well before PV (BCG)
- Prices vs Costs
- Automation, industrialisation, different cost paradigm in China (cheaper equipment...)
- Range of costs and prices: LC is perfect for low prices but what for emerging technologies?
- Modules or cells?
ANOTHER PERSPECTIVE

What about the costs?

Source: Becquerel Institute 2016
PUBLIC DATA AND FORECASTS

- Jinko announced (Q1-2016):
  - 0.37 USD/Wp production costs (others are close: 0.41-0.43)
  - 0.29 USD/Wp end 2017
  - 0.25 USD/Wp in 2020 (First Solar as well)
  - With GPM at 20%: 0.44 USD/Wp (and 0.35 USD FY 2017)

- Prices and cost decline on a 30%+ learning curve

- Official low market prices (Q3-2016): 0.38 USD/Wp

- Prices for large orders: Down to 0.3x USD/Wp ?

- Super competitive tenders (Dubai, Jordan, Peru, India) are done with multi-Si, CdTe or aSi.

- Large part of the PV market with higher prices!
PV PRICE LEARNING CURVE

Source: Becquerel Institute 2016

0.4 USD/Wp

0.45 USD/WP – 275 GW

0.38 USD/WP – 300 GW

97% production

20% LC

37% LC
SIZE MATTERS TO LOWER COSTS

Source: Fraunhofer ISE & IPA, 1 GW Study 2014

Quest for 10 GW is ongoing
WHAT ABOUT TECHNOLOGIES?
THIN FILM LEARNING CURVES

Thin Film Learning Curves (costs and prices) - USD/Wp

Source: Becquerel Institute 2016
THIN FILM ROADMAP

- CdTe LC – 16-20% (Trina Solar, Becquerel Institute)
  - Costs and prices (announced) significantly different

- CIGS LC – 8-10% (Trina Solar, Becquerel Institute)
  - But why? One single main producer on a protected market (JP)? Technology intrinsic characteristics?

- Risk that TF might have difficulties to cope with cSi price decline...?
HOW MUCH NEW CAPACITIES ARE NEEDED (AND WHEN)?

Source: PV Market Alliance – Becquerel Institute 2016
## 2015 CAPACITIES

Table 1. Global PV cell/module/system production volume, production capacity and PV installed capacity in 2015

<table>
<thead>
<tr>
<th>Category</th>
<th>Capacity</th>
<th>YOY Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar cell production</td>
<td>63.0 GW</td>
<td>35.5%</td>
</tr>
<tr>
<td>PV module production</td>
<td>62.1 GW</td>
<td>38.2%</td>
</tr>
<tr>
<td>PV installed capacity (DC-based)</td>
<td>50.0 GW</td>
<td>25.0%</td>
</tr>
<tr>
<td>Solar cell production capacity</td>
<td>71.7 GW/year</td>
<td>23.6%</td>
</tr>
<tr>
<td>PV module production capacity</td>
<td>77.6 GW/year</td>
<td>22.0%</td>
</tr>
<tr>
<td>PV module production in 2014 (for reference)</td>
<td>44.9 GW</td>
<td>22.7%</td>
</tr>
</tbody>
</table>

*Source: RTS Corporation*
HOW MUCH NEW CAPACITIES ARE NEEDED?

Source: Becquerel Institute 2016
A NEW PRICE WAR

Trina Solar warns of overcapacity in 2016. Should the industry panic?

Mar 04, 2016 12:39 PM GMT  |  0

By Mark Osborne, Senior News Editor
3. COMPETITIVE TENDERS

FIGURE 1 PPA PRICE OFFERS FOR SOLAR PV AND WIND ONSHORE POWER PLANTS IN DIFFERENT COUNTRIES

COMPETITIVE TENDERS

Is 0,03 USD/kWh realistic?

What is needed?
- Yield: 2000 kWh/kWp
- CAPEX: 0,7 EUR – 0,8 USD/Wp
- OPEX: 15 EUR/kW
- WACC: 4% (nominal)
- Degradation: 0,5%
SENSITIVITY OF LCOE

Contribution to the LCOE per components in absolute value (LCOE = 0,107 EUR/kWh)

Source: Becquerel Institute 2016

1 EUR/WP CAPEX
30 EUR/Wp OPEX
6% Nominal WACC
1100 kWh/kWp Yield

Source: Becquerel Institute 2016
Average turn-key PV system CAPEX prices in Europe 2015-50 (w/o taxes)

In 2015 real money
RESIDENTIAL PV LCOE IN UK

Residential PV LCOE vs retail electricity price in the UK
Residential PV LCOE vs electricity value in Italy

Source for retail prices: Eurostat 2015 averages for 5-15 MWh annual consumption, fixed components excluded; All prices in 2015 real money
### COMPETITIVENESS

Summary of when true PV competitiveness is reached with 50% self-consumption in residential segment

<table>
<thead>
<tr>
<th>Residential</th>
<th>Nominal WACC</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 kW_p</td>
<td>0% 2% 4% 6%</td>
</tr>
<tr>
<td>Stockholm</td>
<td>2020 2025 2032 2040</td>
</tr>
<tr>
<td>Helsinki</td>
<td>2019 2024 2030 2038</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>Parity Parity 2019 2023</td>
</tr>
<tr>
<td>Paris</td>
<td>Parity 2016 2021 2026</td>
</tr>
<tr>
<td>Brussels</td>
<td>Parity Parity 2018 2022</td>
</tr>
<tr>
<td>Istanbul</td>
<td>Parity Parity 2017 2021</td>
</tr>
<tr>
<td>London</td>
<td>Parity Parity Parity 2018</td>
</tr>
<tr>
<td>Berlin</td>
<td>Parity Parity Parity 2018</td>
</tr>
<tr>
<td>Madrid</td>
<td>Parity Parity Parity 2018</td>
</tr>
<tr>
<td>Rome</td>
<td>Parity Parity Parity 2018</td>
</tr>
</tbody>
</table>
4. 100% RES?

South-East Asia and the Pacific Rim Super Grid for 100% RE power supply

Christian Breyer, Ashish Gulagi and Dmitrii Bogdanov
Lappeenranta University of Technology, Finland
45th IEA PVPS Task 1 Meeting – GÜNDER Workshop
Istanbul, October 27-30, 2015
LCOE of alternatives are NO alternative

Comparison of average remuneration for new nuclear power, PV, wind and the levelized cost of electricity for gas/coal CCS

Key insights
- PV-Wind-Gas is the least cost option (with existing hydro)
- nuclear and coal-CCS is too expensive
- nuclear and coal-CCS are high risk technologies
- high value added for PV-Wind due to higher capacities needed

Current status of the power plant mix

Key insights:
- strongly growing power plant market
- solar PV and wind is growing, but on small basis
- high share of gas plants
- stable share of coal
Scenarios assumptions

15 regions
• 2 regions in Australia (East and West)
• 4 regions in Indonesia (according to major islands)
• 2 regions in Malaysia (East and West)
• Mekong countries

Key data
• ~646 mio population
• ~1629 TWh electricity demand (2030)
• ~256 GW peak load (2030)
• ~13 mio km² area
• ~10 bil m³/a water desalination demand (2030)

South-East Asian Super Grid for 100% RE power supply
Christian Breyer ➤ christian.breyer@lut.fi
## Scenarios assumptions

### Financial assumptions (year 2030)

#### Generation costs

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capex [€/kW]</th>
<th>Opex fix [€/kW]</th>
<th>Opex var [€/kWh]</th>
<th>Lifetime [a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV rooftop</td>
<td>813</td>
<td>12</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>PV fixed-tilted</td>
<td>550</td>
<td>8</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>PV single-axis</td>
<td>620</td>
<td>9</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Wind onshore</td>
<td>1000</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Hydro Run-of-River</td>
<td>2560</td>
<td>115.2</td>
<td>0.005</td>
<td>60</td>
</tr>
<tr>
<td>Hydro Dam</td>
<td>1650</td>
<td>66</td>
<td>0.003</td>
<td>60</td>
</tr>
<tr>
<td>Geothermal energy</td>
<td>4860</td>
<td>87</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Water electrolysis</td>
<td>380</td>
<td>13</td>
<td>0.001</td>
<td>30</td>
</tr>
<tr>
<td>Methanation</td>
<td>234</td>
<td>5</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>CO₂ scrubbing</td>
<td>356</td>
<td>14</td>
<td>0.0013</td>
<td>30</td>
</tr>
<tr>
<td>CCGT</td>
<td>775</td>
<td>19</td>
<td>0.002</td>
<td>30</td>
</tr>
<tr>
<td>OCGT</td>
<td>475</td>
<td>14</td>
<td>0.011</td>
<td>30</td>
</tr>
<tr>
<td>Biomass PP</td>
<td>2500</td>
<td>175</td>
<td>0.001</td>
<td>30</td>
</tr>
<tr>
<td>Wood gasifier CHP</td>
<td>1500</td>
<td>20</td>
<td>0.001</td>
<td>40</td>
</tr>
<tr>
<td>Biogas CHP</td>
<td>370</td>
<td>14.8</td>
<td>0.001</td>
<td>20</td>
</tr>
<tr>
<td>MSW incinerator</td>
<td>5240</td>
<td>235.8</td>
<td>0.007</td>
<td>20</td>
</tr>
<tr>
<td>Steam Turbine</td>
<td>700</td>
<td>14</td>
<td>0</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capex [€/(m²·a)]</th>
<th>Opex fix [€/(m²·a)]</th>
<th>Opex var [€/(m³·a)]</th>
<th>Lifetime [a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Desalination</td>
<td>2.23</td>
<td>0.096</td>
<td>0</td>
<td>30</td>
</tr>
</tbody>
</table>

#### Technology vs. Energy/Power Ratio [h]

- Battery: 6
- PHS: 8
- A-CAES: 100
- Gas Storage: 80 x 24

#### Efficiency [%]

- Battery: 90
- PHS: 92
- A-CAES: 70
- Gas Storage: 100
- Water Electrolysis: 84
- CO₂ Scrubbing: 78
- Methanisation: 77
- CCGT: 58
- OCGT: 43
- Geothermal energy: 24
- MSW Incinerator: 34
- Biogas CHP: 40
- Steam Turbine: 42
- CSP collector: 51

---

South-East Asian Super Grid for 100% RE power supply
Christian Breyer • christian.breyer@lut.fi
Scenarios assumptions
PV and Wind LCOE (weather year 2005, cost year 2030)

PV (1-axis tracking) LCOE

Wind (E101 at 150m) LCOE

CSP LCOE

South-East Asian Super Grid for 100% RE power supply
Christian Breyer ➤ christian.breyer@lut.fi
Scenarios assumptions
Generation profile (area aggregated)

PV generation profile
Aggregated area profile computed using earlier presented weighed average rule.

Wind generation profile
Aggregated area profile computed using earlier presented weighed average rule.
Scenarios assumptions
Load (area aggregated)

Synthesized load curves for each region

Total load (2030)

Key insights:
- PV self-consumption reduces peak load by about 5%
- Daytime demand is substantially reduced throughout the year

South-East Asian Super Grid for 100% RE power supply
Christian Breyer ▶ christian.breyer@lut.fi
Results

Total LCOE (year 2030) – region-wide open trade

Levelized Cost of Electricity
(generation, curtailment and storage)

Average LCOE: 0.057 €/kWh

South-East Asian Super Grid for 100% RE power supply
Christian Breyer ➤ christian.breyer@lut.fi
SELF-CONSUMPTION
ROOFTOP PV DEVELOPMENT

GLOBAL PV MARKET EVOLUTION BY SEGMENT UNTIL 2020

UTILITY SCALE

ROOFTOP


PV Market Alliance
BUSINESS MODELS

Prosumers

Savings on the electricity bill + Sale of excess PV electricity

Net-metering
Self-consumption + market price + FiT/FiP

Producers

Sale of electricity

FiT / TGC
Market price (+ premium? FiP)
WITH OR WITHOUT PV

Building without PV
- Electricity comes from the grid

Building with PV
- Part of electricity produced by PV is consumed in the building (reducing the electricity bill)
- Non-consumed electricity goes to the grid and is sold
- When PV is not producing, the electricity comes from the grid
COMPETITIVE PV?

CAPEX of PV System + OPEX of PV System - Savings on electricity bills + Sales of excess electricity

During PV systems’ lifetime (20-35 years)
ECONOMICS OF SELF-CONSUMPTION

+ self-consumption taxes

+ sales of PV electricity

Savings & Sales
### COMPONENTS OF ELECTRICITY

**How much can be compensated from the electricity bill?**

During PV systems' lifetime (25 years)

<table>
<thead>
<tr>
<th>Country</th>
<th>Maximum savings on electricity bills (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>79%</td>
</tr>
<tr>
<td>Germany</td>
<td>83%</td>
</tr>
<tr>
<td>Austria</td>
<td>85%</td>
</tr>
<tr>
<td>Denmark</td>
<td>94%</td>
</tr>
<tr>
<td>Poland</td>
<td>96%</td>
</tr>
<tr>
<td>UK</td>
<td>97%</td>
</tr>
<tr>
<td>Portugal</td>
<td>97%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>97%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>97%</td>
</tr>
<tr>
<td>Belgium</td>
<td>97%</td>
</tr>
<tr>
<td>France</td>
<td>97%</td>
</tr>
<tr>
<td>Turkey</td>
<td>98%</td>
</tr>
<tr>
<td>Italy</td>
<td>99%</td>
</tr>
</tbody>
</table>
SALES OF PV ELECTRICITY

1. **Current**  
   Excess PV electricity gets a FiT

2. **Current**  
   Excess PV electricity gets a FiP above the market price

3. **Future**  
   Excess PV electricity gets the market price though an aggregator

4. **Future**  
   Excess PV electricity gets the market price directly

European Legislation pushed to integrate renewable into wholesale electricity markets
SELF-CONSUMPTION RATIO

SC ratio = PV production locally consumed / total PV production

Hypothesis used: 50% SC - Commercial segment / 75% SC - Industrial segment

- Example: commercial segment in France 2015
  - Retail electricity price: 0,144 EUR/kWh
  - Wholesale market price: 0,045 EUR/kWh
  - Average value of PV electricity compared to the LCOE of PV electricity (average): 0,10 EUR/kWh

<table>
<thead>
<tr>
<th>SC</th>
<th>Cost (EUR/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>0,061</td>
</tr>
<tr>
<td>50%</td>
<td>0,083</td>
</tr>
<tr>
<td>75%</td>
<td>0,116</td>
</tr>
<tr>
<td>100%</td>
<td>0,144</td>
</tr>
</tbody>
</table>
THE SC RATIO CHALLENGE

Self-consumption of PV installations
20 to 100%

Challenge: minimizing grid injection
Solutions: decrease PV system size, DSM, Storage
Ratios are smaller in the residential sector (20-30%).

DSM, system size, storage can increased them.

Commercial and industrial applications can reach higher ratios.

But is local optimization of SC optimum from a system point of view?
SELF-CONSUMPTION BUSINESS CASE

- A simple (residential) business model in Belgium
  
  PV electricity production cost: 0,12 EUR/kWh (950 kWh/kWp + 1,5 EUR/WP + WACC @ 4%)
  
  Residential electricity prices 0,2 EUR/kWh (assuming 100% savings on electricity bill)
  
  Value of injected electricity = 0,04 EUR/kWh

  (Net-metering with grid tax:  +0,13 – 0,12 = +0,01 EUR/kWh)

  With 30% SC:  +0,09 – 0,12 = -0,03 EUR/kWh
  
  With 70% SC:  +0,15 – 0,12 = +0,03 EUR/kWh

  Margin for investment in Smart tools, storage or H&C
  
  NPV_20years (i=2%) for a 5kWp PV system = 2400 EUR
REGULATIONS & PARAMETERS
A NEED FOR REGULATIONS

<table>
<thead>
<tr>
<th>Onsite Self-Consumption</th>
<th>Right to self-consume</th>
<th>Revenues for self-consumed PV electricity</th>
<th>Charges to finance T&amp;D costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Self-consumption is legally permitted</td>
<td>• Savings on the variable price of electricity from the grid</td>
<td>• Additional costs associated to self-consumption such as fees or taxes may exist</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excess PV Electricity</th>
<th>Value of excess electricity</th>
<th>Maximum timeframe for compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Net metering: energetic compensation (credit in kWh)</td>
<td>• Self-consumption: real time (e.g. 15 minutes)</td>
</tr>
<tr>
<td></td>
<td>• Net billing: monetary compensation (credit in monetary unit)</td>
<td>• Net metering and net billing: time frame is typically one year although there are some exceptions (from credits that can be rolled over to the following billing cycle to quarterly compensation)</td>
</tr>
</tbody>
</table>

Key:
- Red: Same between schemes
- Blue: Main differences
CATEGORIES OF SELF-CONSUMPTION

<table>
<thead>
<tr>
<th>On-site PV self-consumption</th>
<th>1</th>
<th>Right to self-consume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Revenues from self-consumed PV</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Charges to finance T&amp;D costs</td>
</tr>
<tr>
<td>Excess PV electricity</td>
<td>4</td>
<td>Revenues from excess electricity</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Maximum timeframe for credit compensation</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Geographical compensation</td>
</tr>
<tr>
<td>Other characteristics of the system</td>
<td>7</td>
<td>Regulatory scheme duration</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Third-party ownership</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Grid codes and additional taxes/fees</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Other enablers of self-consumption</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>System capacity limit</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Aggregate capacity limit</td>
</tr>
</tbody>
</table>

Clarify existing and future schemes,
Allow comparison from one scheme to another
Consider some emerging questions such as:
- How to finance the grid?
- How to keep government revenues stable?
- How to save utilities?
## WHICH POLICIES?

<table>
<thead>
<tr>
<th></th>
<th>Production based: classical &quot;FiT&quot; - style. No self-consumption</th>
<th>Self-consumption with constrains</th>
<th>Self-consumption + FiT</th>
<th>Net-billing</th>
<th>Net-metering</th>
<th>Self-consumption + Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Right to self-consume</td>
<td>Not Allowed</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Revenues from self-consumed PV</td>
<td>N/A</td>
<td>Savings on the electricity bill</td>
<td>Savings on the electricity bill</td>
<td>Netting of production revenues and consumption costs</td>
<td>Savings on the electricity bill</td>
</tr>
<tr>
<td></td>
<td>Additional revenues on self-consumed PV</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Charges to finance T&amp;D cost</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Revenues from excess electricity</td>
<td>N/A</td>
<td>Zero</td>
<td>&lt;= retail price</td>
<td>= retail price</td>
<td>&gt; retail price</td>
</tr>
<tr>
<td>5</td>
<td>Maximum timeframe for compensation</td>
<td>N/A</td>
<td>Real-time</td>
<td>Real-time</td>
<td>Long period</td>
<td>Long period</td>
</tr>
</tbody>
</table>
THE DEBATE ON SELF-CONSUMPTION

Self-consumption will be constrained due to limited savings on the electricity bill.
IN SUMMARY...

**Competitiveness?**

- 2015
  - 3% WACC
  - 6.5% WACC
  - 10% WACC

**Which Incentives?**

- PV Penetration in the electricity mix
  - FiT and similar
  - Competitive bids / system oriented
  - Tax br.
  - Self-consumption based schemes
  - Private PPAs
  - Market based remuneration?

Grid parity threshold (PV LCOE < retail prices)

**Market Integration?**

**Cost of financing**

**Quality & Reliability**

Local industry vs low prices?

---

Solar United – UNSW October 2016
Becquerel Institute
NEXT STEP IN EVOLUTION
Thanks for your attention

g.masson@becquerelinstiute.org

g.masson@iea-pvps.org

Becquerelinstiute.org

www.pvmarketalliance.com

Solarunited.org