Roof-top PV – the new market in Chile

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Matthias Grandel
GIZ in Chile

- GIZ is a German Federal Organization for the sustainable development through international cooperation.
- The organization works in more than 130 countries worldwide and has been 25 years in Chile.
- Together with the Chilean Energy Ministry the project “Solar Energy for Power and Heat Generation” has been developed, dedicated to the solar energy self-generation.
- Other projects developed by the energy program 4E of GIZ:
  - CSP and large scale PV plants
  - Efficient cogeneration
Roof-top PV – the new market in Chile

....the legal framework for self-consumption and feed-in is in place.....

....there is market potential and economic feasibility.......

....However, some barriers still exist.......

....but many initiatives underway to remove the barriers.......
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- Distribution company remunerates regulated energy price (59.2 CLP/KWh (8.6 ct US$) in Santiago)
- Customers with power connection < 10 kW pay integrated price per energy and grid fee (102.3 CLP/kWh (14.8 ct US$) in Santiago => Net Billing)
- Customers with power connections > 10 kW pay for energy and grid separately => Net Metering
Installations up to 9 MW can sell excess energy on spot-market, via PPA, or based on regulated wholesale prices.

It is also possible to use 100% of produced electricity without feed-in to the network.

- **Net Billing**
- **Net Metering**
- **PMGD (small and medium scale distributed generation)**
- **Norma 4 (NCH Elec. 4/2003)**
Roof-top PV – Legal Framework

http://www.minenergia.cl/ley20571/
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Market Potential and economic feasibility

- Correlation between regulated electricity prices and solar irradiation.
- Higher electricity prices in the southern-central part of Chile drive self-consumption market potential.

- ca. 600 thousand households (11% of Santiago’s population) with average incomes 3 million CLP/month. (c.a. US$ 4,500)

Market Potential and economic feasibility

> 25 Technical and economic feasibility studies conducted:

- Arica - Concepción
- All Tariffs: BT1a – AT4.3, clientes libres
- Various economic sectors: Residencial, SME, retail, industry, agriculture, public sector, etc.
- Very high interested of clients/companies
Market Potential and economic feasibility

Profitability depends on:

- Regular (grid) electricity cost vs. self-generated cost
- Capital cost/discount rate
- Share of self-consumption (for residential customers/m SMEs with BT1a)

Example in Santiago:

<table>
<thead>
<tr>
<th>Description</th>
<th>Payback simple</th>
<th>Payback (10% discount rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R: 2,6 kW at 1,3 Mio CLP kWp (incl. IVA)</td>
<td>9 years &amp; 9 months</td>
<td>23 years</td>
</tr>
<tr>
<td>C: 100 kW at 1,0 Mio CLP kWp (sin IVA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential 50% self supply</td>
<td>9 years &amp; 9 months</td>
<td>23 years</td>
</tr>
<tr>
<td>Residential 75% self supply</td>
<td>8 years &amp; 7 months</td>
<td>17 years</td>
</tr>
<tr>
<td>mSMEs 100% self supply</td>
<td>7 years &amp; 8 months</td>
<td>13 years &amp; 8 months</td>
</tr>
<tr>
<td>Commercial (AT 4.3)</td>
<td>10 years &amp; 9 months</td>
<td>&gt; 25 years</td>
</tr>
</tbody>
</table>
Market Potential and economic feasibility

LCOE calculation for Calama:

- red values are higher than the current energy tariff for high tension tariff (AT4.3)

<table>
<thead>
<tr>
<th>Investment [USD/kW]</th>
<th>7%</th>
<th>8%</th>
<th>9%</th>
<th>10%</th>
<th>11%</th>
<th>12%</th>
<th>13%</th>
<th>14%</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1395</td>
<td>41.7</td>
<td>45.3</td>
<td>49.0</td>
<td>52.8</td>
<td>56.7</td>
<td>60.6</td>
<td>64.7</td>
<td>68.7</td>
<td>72.9</td>
</tr>
<tr>
<td>1550</td>
<td>46.4</td>
<td>50.4</td>
<td>54.5</td>
<td>58.7</td>
<td>63.0</td>
<td>67.4</td>
<td>71.8</td>
<td>76.4</td>
<td>81.0</td>
</tr>
<tr>
<td>1705</td>
<td>51.0</td>
<td>55.4</td>
<td>59.9</td>
<td>64.5</td>
<td>69.3</td>
<td>74.1</td>
<td>79.0</td>
<td>84.0</td>
<td>89.1</td>
</tr>
<tr>
<td>1860</td>
<td>55.7</td>
<td>60.4</td>
<td>65.4</td>
<td>70.4</td>
<td>75.6</td>
<td>80.8</td>
<td>86.2</td>
<td>91.7</td>
<td>97.2</td>
</tr>
<tr>
<td>2016</td>
<td>60.3</td>
<td>65.5</td>
<td>70.8</td>
<td>76.3</td>
<td>81.9</td>
<td>87.6</td>
<td>93.4</td>
<td>99.3</td>
<td>105.3</td>
</tr>
</tbody>
</table>
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....but many initiatives underway to remove the barriers......
...some barriers still exist...

Market starts very slowly – statistics of Net-Metering/Billing (30.9.):

- Number of “solicitudes de conexión”: 366
- Number of connections “TE4”: 41 in process (674 kW), 15 inscribed (225 kW)

Conclusions from feasibility studies:

- High profitability expectation of Chilean clients
  - payback < 5 years and very high discount rate (10 – 20%)
    - *Need for new business modells, e.g. ESCO*
- Lack of experience and confidence in purchasing PV-Systems or services
  - Insecurity regarding technical requirements
  - Long decision process
    - *Need for information and patience*
...some barriers still exist...

Prices in Chile still higher than the international price

Comparison of net cost of PV systems by Wp (May 2015)

Source: GIZ Chile, Mercado Público Chile
...some barriers still exist...

More barriers:

- Local banks usually do not finance small scale projects

  - Approx. 150 PV-companies:
    - Mostly new and very small companies with limited project experience
    - only few local and international companies with intensive experience of rooftop-PV
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...activities to remove the barriers...

“Programa Techos Solares Públicos”

- 13 Mio. USD until 2018 for PV-Systems in public buildings
- Open public tender for national and international PV enterprises.
- Size of installations between 5 – 100 kWp.
- Main Objective:
  - Mature the PV-rooftop market by public demand
  - Provide information on costs and conditions
  - Try and improve the legal framework
  - Lower costs of energy in public buildings

www.minenergia.cl/techossolares
...activities to remove the barriers...

Legal and fiscal Analysis of PV-contracting/ESCO business model for PV self-supply:

- The ESCO is owner and responsible for the equipment and the electricity production
- Customers buy the generated electricity
...activities to remove the barriers...

- “solar laboratories” at six vocational training institutions and universities to promote sufficient well-trained installers.

- Laboratories can be rented by companies or other training centers for workshops or training of own technicians.

PV system  Solar laboratories
Conclusion:
The roof-top PV market is up and coming
.... the legal framework for self-consumption and feed-in is in place....
..... there is market potential and economic feasibility.......
..... However, some barriers still exist.......
....but many initiatives underway to remove the barriers.......

Recommendation:
• Enter the market with confidence and patience to convince the potential customers.
• Offer contracting/ESCO-models and sell only electricity to the customers.
Muchas Gracias!

Tienen preguntas?

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https://energypedia.info/wiki/Solar_Energy_for_Electricity_and_Heat_in_Chile

www.4echile.cl, www.giz.de
BACK-UP
**Legal Framework - one year of Net-Billing/Metering**

**Application process for plants <100 kW under Net-Billing (simplified)**

<table>
<thead>
<tr>
<th>Before the project</th>
<th>Project implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appliance for grid connection</strong></td>
<td><strong>Installation of the plant</strong></td>
</tr>
<tr>
<td>customer -&gt; distribution grid operator</td>
<td>customer</td>
</tr>
<tr>
<td><strong>Answer (20 days)</strong></td>
<td><strong>Announcement of commissioning</strong></td>
</tr>
<tr>
<td>distribution grid operator -&gt; customer</td>
<td>customer -&gt; electricity grid supervisor SEC</td>
</tr>
<tr>
<td><strong>Installation of the plant</strong></td>
<td><strong>Announcement of grid-connection</strong></td>
</tr>
<tr>
<td>customer</td>
<td>customer</td>
</tr>
<tr>
<td><strong>Announcement of grid-connection</strong></td>
<td><strong>Grid connection contract (5 days)</strong></td>
</tr>
<tr>
<td>customer</td>
<td>customer &amp; distribution grid operator</td>
</tr>
<tr>
<td><strong>Grid connection contract (5 days)</strong></td>
<td><strong>Inspection of grid connection (20 days)</strong></td>
</tr>
<tr>
<td>customer &amp; distribution grid operator</td>
<td>distribution grid operator</td>
</tr>
<tr>
<td><strong>Inspection of grid connection (20 days)</strong></td>
<td><strong>Commissioning of the plant</strong></td>
</tr>
<tr>
<td>distribution grid operator</td>
<td>customer</td>
</tr>
</tbody>
</table>

**Before the project**
- 6 months for installation and connecting after approval through distribution grid operator.

**Customer need to pay for modification of the distribution network, in case it is necessary.**

**Distribution grid operator is demanding adjustments**
- Strengthening of grid and/or lowering of plant capacity.

**Customer assigns work on distribution grid and/or reduces plant capacity**

**Source:** Büro F based on Ministerio de Energía, GIZ Chile
LCOE calculation

- Parameters for the calculation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy generation</td>
<td>1446720</td>
<td>kWh/año</td>
</tr>
<tr>
<td>Generation annual losses</td>
<td>0.50%</td>
<td></td>
</tr>
<tr>
<td>unitary investment</td>
<td>1400-2000</td>
<td>USD/kW</td>
</tr>
<tr>
<td>Capacity</td>
<td>750</td>
<td>kW</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td>0.5 %</td>
<td>% of the investment</td>
</tr>
<tr>
<td>Discount rate</td>
<td>7%-15%</td>
<td></td>
</tr>
<tr>
<td>Life time</td>
<td>20</td>
<td>Years</td>
</tr>
<tr>
<td>Soc. tax rate</td>
<td>22.5%</td>
<td>% (source: SII)</td>
</tr>
<tr>
<td>depreciation type</td>
<td>Lineal</td>
<td></td>
</tr>
</tbody>
</table>
Data for the profitability calculation

Capacity factor: 20%
System life time: 25 years (with a panels’ annual degradation of 0,5%)
Discount rate: 10%
Increase in the electricity price (buy and injection): 3,5%
Inflation: 2%
Annual maintenance cost: 2% of CAPEX

Residential BT1 Tariff (low tension 1), Chilectra distributer:
• Injection: 59.5789 CLP/kWh (net)
• Buy: 102.636 CLP/kWh (with IVA)

AT4.3 tariff (high tension 4.3), Chilectra distributer
• Injection: 56,59 CLP/kWh
• Buy: 56,59 CLP/kWh

CAPEX 2,6 kW: 2.859.243 (net), with IVA 3.4 Mio. CLP, according to the price index and offers (1.099.708 CLP/kWp (net)) = 1.308.653 CLP/kWp (with IVA)
CAPEX 100kW: 100 000 000 (net), according to the price index