Economic Loss in Czech Photovoltaic Power Plants

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Research topic

Research question
How much money was lost in Czech PV subsidies?

(The cost of decreasing CO2 emissions.)
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Understanding Subsidies

Czech PV Plants

Cost of PV Subsidies

Conclusions
Understanding Subsidies

Czech PV Plants

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The Idea of Renewable Subsidies

We introduce a *green tax* which raises the price of electricity.

The proceeds are redistributed to some chosen electricity sources which:

- are not economically viable without subsidies; and
- are supposed to generate less CO2 emissions.

**Hypothesis**

This causes significant cost inefficiency on the market.
Decomposition of the Subsidies

We can decompose the subsidies into three components:

1. \( p(01) \): Equivalent to the normal market price
2. \( p(02) \): Covers the excessive cost by the given renewable source
   \[ \Rightarrow \text{extra social cost ("dead weight loss") } \]
3. \( p(03) \): Generates additional profit for the plant owner/operator (both for shareholders and creditors)
   \[ \Rightarrow \text{the redistributive component} \]
Implications in Practice

Figure: The Impact of PV Subsidies on the Electricity Market

Note: Proportions in this figure do not correspond to real values. AC includes the interest accrued to creditors and shareholders.
Empirical Supply Curve

Figure: Estimated unit electricity costs in EUR/MWh according to BCG.
The Redistributive Nature of Subsidies

\textit{p(02): Extra social cost ("DWL")}

This is artificial cost in the economy that would not exist were it not for the subsidies. It is equivalent to a certain sum of goods which could have been produced instead and which would have increased consumer utility. It is incurred for the sake of decreasing CO2 emissions.

\textit{p(03): Income regressive tax}

The green tax hits relatively more those poor consumers for whom electricity represents higher share of their bills. The profit goes to rich individuals who were able to invest into PV plants.
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Sample PV Plants

Table: Production of sample PV plants in 2010.

<table>
<thead>
<tr>
<th></th>
<th>Capacity $MW_{e}$</th>
<th>Production $MWh$ netto</th>
<th>Capacity usage $MWh/MW_{e}$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>REN POWER II</td>
<td>7.3</td>
<td>5,130</td>
<td>706</td>
<td>8.06%</td>
</tr>
<tr>
<td>Solar Stříbro</td>
<td>13.6</td>
<td>13,056</td>
<td>959</td>
<td>10.95%</td>
</tr>
<tr>
<td>BS Park I</td>
<td>8.1</td>
<td>2,637</td>
<td>325</td>
<td>3.71%</td>
</tr>
<tr>
<td>FVE Czech</td>
<td>6.1</td>
<td>6,372</td>
<td>1,047</td>
<td>11.95%</td>
</tr>
<tr>
<td>Papeno</td>
<td>8.4</td>
<td>5,222</td>
<td>618</td>
<td>7.06%</td>
</tr>
<tr>
<td>CEZ OZ</td>
<td>21.3</td>
<td>15,911</td>
<td>747</td>
<td>8.53%</td>
</tr>
<tr>
<td>All plants</td>
<td>64.8</td>
<td>48,328</td>
<td>734</td>
<td>8.38%</td>
</tr>
</tbody>
</table>

Source: Energy Regulatory Office, own calculation.

Observation

Very low usage, effective production capacity rather low
Balance Sheet Indicators

<table>
<thead>
<tr>
<th></th>
<th>Equity to Assets</th>
<th>PPE to MW_e</th>
<th>Liabilities to MW_e</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>CZK mil.</td>
<td>CZK mil.</td>
</tr>
<tr>
<td>REN POWER II</td>
<td>3.52%</td>
<td>63.9</td>
<td>68.9</td>
</tr>
<tr>
<td>Solar Stribro</td>
<td>23.28%</td>
<td>116.7</td>
<td>99.3</td>
</tr>
<tr>
<td>BS Park I</td>
<td>-0.20%</td>
<td>15.8</td>
<td>24.3</td>
</tr>
<tr>
<td>FVE Czech</td>
<td>4.56%</td>
<td>94.4</td>
<td>97.4</td>
</tr>
<tr>
<td>Papeno</td>
<td>9.22%</td>
<td>61.5</td>
<td>64.9</td>
</tr>
<tr>
<td>Average</td>
<td>8.08%</td>
<td>70.5</td>
<td>70.9</td>
</tr>
</tbody>
</table>

Source: Czech Business Register, own calculation.

Observation
Extremely high leverage, the plants are effectively owned by banks
Table: Cost Decomposition for Sample PV Plants.

<table>
<thead>
<tr>
<th></th>
<th>Revenue CZK/MWh</th>
<th>EBITDA CZK/MWh</th>
<th>Depreciation CZK/MWh</th>
<th>Interest CZK/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>REN POWER II</td>
<td>15,444</td>
<td>15,079</td>
<td>5,497</td>
<td>4,068</td>
</tr>
<tr>
<td>Solar Stribro</td>
<td>13,125</td>
<td>10,403</td>
<td>4,645</td>
<td>6,033</td>
</tr>
<tr>
<td>Average</td>
<td>14,284</td>
<td>12,741</td>
<td>5,071</td>
<td>5,051</td>
</tr>
</tbody>
</table>

Source: Czech Business Register, own calculation.

Table: Income Statement to Balance Sheet Ratios for Sample PV Plants.

<table>
<thead>
<tr>
<th></th>
<th>EBITDA/Assets</th>
<th>Depreciation/PPE</th>
<th>Interest/Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>REN POWER II</td>
<td>14.8%</td>
<td>6.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Solar Stribro</td>
<td>7.7%</td>
<td>3.8%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Average</td>
<td>11.3%</td>
<td>5.1%</td>
<td>6.4%</td>
</tr>
</tbody>
</table>

Source: Czech Business Register, own calculation.
Observation

The two most important cost items of PV plants are:

1. Depreciation = cost of installed equipment
2. Interest payments on debt = quasi-dividends to financing banks
Shadow PV Electricity Price

What would be the price of PV electricity on the market?

We need:

1. Hourly market prices: Easy to get from OTE
2. Hourly production of PV plants: Difficult to get, unique data from ČEPS

We calculate weighted average: **1,091.5 CZK/MWh** (2010)

This is almost the same as average market price: **1,087 CZK/MWh**
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Income Method

We calculate the sum of subsidies above market/shadow market price.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production MWh</th>
<th>Feed-in tariff avg., CZK/MWh</th>
<th>Market price avg., CZK/MWh</th>
<th>Cost CZK mil.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 (A)</td>
<td>615,700</td>
<td>12,717</td>
<td>1,087</td>
<td>7,161</td>
</tr>
<tr>
<td>2010 (B)</td>
<td>615,700</td>
<td>12,717</td>
<td>1,092</td>
<td>7,158</td>
</tr>
<tr>
<td>2009</td>
<td>88,800</td>
<td>13,498</td>
<td>1,026</td>
<td>1,107</td>
</tr>
</tbody>
</table>

Source: Energy Regulatory Office, OTE, own calculation.

Result

The cost of PV subsidies amounts to CZK 7.2 billion.
Each MW of generation capacity requires roughly CZK 70 million in capital expenditures.

2010 installed capacity was 1,820 MW ⇒ CZK 127.4 billion in sunk costs.

These assets are depreciated over 20 years.

**Result**
Annual shock to the economy CZK 6.4 billion in missing capex spending.
Profit Accounting

\[
PL = \text{Revenues} - \text{Costs}
\]

\[
= \text{capacity} \times \text{usage} \times \text{electricity price} - \text{depreciation} - \text{interest}
\]

\[
= \frac{\text{PPE} \times \text{usage} \times \text{electricity price}}{\text{cost per MW}} - \text{PPE} \times \text{depreciation rate} - \text{PPE} \times \frac{\text{debt}}{\text{PPE}} \times \text{interest rate}
\]

\[
PL = \text{PPE} \times \left[ \frac{\text{usage} \times \text{electricity price}}{\text{cost per MW}} - \delta - \lambda \times i \right]
\]

\[
= [\text{CZK}] \times \left\{ \left[ \frac{[h] \times [\text{CZK/MWh}]}{[\text{CZK/MW}]} \right] - [\%] - [\%] \times [\%] \right\} = [\text{CZK}]
\]
**Profit Accounting: Result**

\[
PL = 127.4 \times \left[ \frac{734 \times 1,092}{70,000,000} - 0.051 - 1.09 \times 0.064 \right] \\
= 127.4 \times [0.011 - 0.051 - 0.070] \\
= 127.4 \times (-0.11) 
\]

(2)

**Result**

The cost of PV subsidies amounts to CZK 14 billion, of which

- 42% (5.9 bn) is the pure DWL \( p(02) \),
- 58% (8.1 bn) is the redistributive profit component \( p(03) \).

Either the price would have to increase tenfold, or the required capex would have to decrease tenfold, to make PV plants profitable.
Conclusions

1. Estimated sunk costs in PV plants amounted to CZK 127.4 billion at the end of 2010.

2. Each million invested in PV plants generates annual loss of 11%, of which
   - 42% is the pure dead weight loss,
   - 58% is the redistributive profit component which is tax regressive, benefiting mostly the financing banks.

3. At this rate the PV sector generated annual costs of CZK 14 billion in 2011 to the Czech economy.

4. This result is highly insensitive to small changes in parameters. A turn-around of PV plants would require a tenfold shift in either the required capex, or the electricity prices.

5. These costs are to be measured against potential benefits of decreased CO2 emissions.
Conclusions

Thank you for your attention.