ARMENIA RENEWABLE RESOURCES AND ENERGY EFFICIENCY FUND

Tamara Babayan
R2E2

• Established in 2005 by the RA Government

• Mission: to facilitate investments in energy efficiency and renewable energy

• Implemented projects >$40 mln
Energy Efficiency Project

• Objective: reducing energy consumption in public buildings

• WB/GEF grant: $1.8 million

• RA funding: $8 million

• Beneficiaries: social and public facilities

• EE activities: insulation of walls and roofs, replacement of windows, modernization of heating system, replacement of street lighting system.
• Funding public facilities (hospital, school, administrative building or lighting system) from community or RA state budget allocations

• Lean budget and rising tariffs

• Underpopulated buildings and financing per pupil

• Poor comfort level: ~40%

• In general, energy expenditure remains the second after salary (5-20%)

• Poor building conditions

• Consumption: for heating, hot water, food preparation and electricity for activities.
Standards

• Comfort level > 50%
• Estimated energy saving > 20%
• NPV > 0
• Simple payback < 10 years
• Investments > $ 50,000.
The Geography of EEP

- Hospital
- University
- School
- Kindergarten
- Administrative building
- Street lighting
Background Information on Energy Efficiency Project at Schools

- Total number of schools: 6 / 19823 m²
- Total financial investment: 137 mln. AMD:
  - Between 19.0-29.0 mln. AMD, on average 22.8 mln. AMD/m²
  - Between 5300-9000 AMD/m², on average 7200 AMD/m²
- Simple payback period: 7.1...7.2 years
- Energy efficiency 52.3...58.0%
- Heat needed for heating (kWh/year):
  - before ES measures: 2286767 ► after: 1053737 (-53.9%)
- Specific heat consumption needed for heating:
  - before ES measures: 120 kWh/m²/year ► after: 55 kWh/m²/year
- Reduction in CO₂ emissions:
  - before ES measures: 471.8 t/year ► after: 218.2 t/year (-53.7%).
Specific investments in energy saving in accordance with the school’s heated surface

<table>
<thead>
<tr>
<th>School</th>
<th>Specific investments, AMD/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ararat School No. 4</td>
<td>9,720</td>
</tr>
<tr>
<td>Masis School No. 2</td>
<td>6,810</td>
</tr>
<tr>
<td>Lchashen School</td>
<td>7,423</td>
</tr>
<tr>
<td>Gavar School No. 5</td>
<td>8,130</td>
</tr>
<tr>
<td>Mets Masrik School</td>
<td>6,240</td>
</tr>
<tr>
<td>Yerevan School No. 21 after Shirvanzade</td>
<td>5,550</td>
</tr>
</tbody>
</table>
Specific heat consumption at schools

<table>
<thead>
<tr>
<th>School</th>
<th>Before ESM</th>
<th>after ESM</th>
<th>on average before ESM</th>
<th>on average after ESM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ararat School No. 4</td>
<td>182</td>
<td>116</td>
<td>182</td>
<td>116</td>
</tr>
<tr>
<td>Masis School No. 2</td>
<td>125</td>
<td>57</td>
<td>125</td>
<td>57</td>
</tr>
<tr>
<td>Lchashen School</td>
<td>125</td>
<td>67</td>
<td>125</td>
<td>67</td>
</tr>
<tr>
<td>Gavar School No. 5</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Mets Masrik School</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Yerevan School No. 21 after</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Shirvanzade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annual financial expenditure for heating and saving (in AMD) before and after energy saving measures in Vayk Kindergarten No. 3

Before ESM
- Saved amount: 540,923
- Tariff raising: 2,097,879

After ESM
- Repayment of ESM amount: 719,925
- Payments for gas: 1,845,966
- Other payments: 792,836

At previous tariff rate:
- Payments for gas: 792,836
Annual financial expenditure for heating and saving (%) before and after energy saving measures in Vayk Kindergarten No. 3

- Before ESM:
  - 79.5% Saved amount
  - 100.0% Tariff raising

- After ESM:
  - 27.3% repayment of ESM amount
  - 42.7% payments for gas
  - 30.0% at previous tariff rate

Payments for gas after ESM:
- 30.0%
Annual financial expenditure for heating and saving (%) before and after energy saving measures in Masis Medical Centre

Before ESM
- Saved amount: 78.9%
- Tariff raising: 21.1%

After ESM
- Repayment of ESM amount: 46.8%
- Payments for gas: 77.6%
- At previous tariff rate: 22.4%
- Saved amount: 30.7%
Annual financial expenditure for heating and saving (%) before and after energy saving measures
At National Archives of Armenia

<table>
<thead>
<tr>
<th></th>
<th>Before ESM</th>
<th>After ESM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saved amount</td>
<td>16.5%</td>
<td>41.9%</td>
</tr>
<tr>
<td>Tariff raising</td>
<td>83.5%</td>
<td>58.1%</td>
</tr>
<tr>
<td>Repayment of ESM amount</td>
<td>100.0%</td>
<td>58.1%</td>
</tr>
<tr>
<td>Payments for gas</td>
<td></td>
<td>24.3%</td>
</tr>
<tr>
<td>at previous tariff rate</td>
<td></td>
<td>17.6%</td>
</tr>
</tbody>
</table>
Buildings’ Accident rate

- III or IV grade dangerous buildings are not considered.
Roof condition
Armenian State University of Economics

Before

After
Entrance of the Armenian State University of Economics

Before

After
Lchashen School

Northern side

Sun-facing side
Scalding UP Renewable Energy Program

Climate Investment Fund
EE Potential in Armenia

Map of Surface Hydrology (rivers, lakes, reservoirs)

Hydro 250-300 MW
**Wind**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Wind Power Density at 50 m W/m²</th>
<th>Wind Speed at 50 m m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>0 - 200</td>
<td>0 - 6.0</td>
</tr>
<tr>
<td>Marginal</td>
<td>200 - 300</td>
<td>6.0 - 6.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>300 - 400</td>
<td>6.8 - 7.5</td>
</tr>
<tr>
<td>Good</td>
<td>400 - 500</td>
<td>7.5 - 8.1</td>
</tr>
<tr>
<td>Excellent</td>
<td>500 - 600</td>
<td>8.1 - 8.6</td>
</tr>
<tr>
<td></td>
<td>600 - 800</td>
<td>8.6 - 9.5</td>
</tr>
<tr>
<td></td>
<td>&gt;800</td>
<td>&gt;9.5</td>
</tr>
</tbody>
</table>

*Wind speeds are based on an elevation of 2000 m and a Weibull k value of 2.0.*
TAMARA BABAYAN
Director of R2E2 Fund

Solar
>1000 MW

Total Horizontal Radiation (kWh/m² year)
Geothermal
25-150 MW
## EE Potential

<table>
<thead>
<tr>
<th>Technology</th>
<th>Capacity (MW)</th>
<th>Generation (GWh/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>300</td>
<td>650</td>
</tr>
<tr>
<td>Solar PV</td>
<td>830 – 1,200(^a)</td>
<td>1,700 – 2,100(^a)</td>
</tr>
<tr>
<td>Concentrating solar power (CSP)</td>
<td>1,200</td>
<td>2,400</td>
</tr>
<tr>
<td>Distributed solar PV</td>
<td>1,300</td>
<td>1,800</td>
</tr>
<tr>
<td>Geothermal</td>
<td>at least 150</td>
<td>at least 1,100</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>SHPP</td>
<td>100</td>
<td>340</td>
</tr>
<tr>
<td>Biogas</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>Biomass</td>
<td>30</td>
<td>230</td>
</tr>
<tr>
<td><strong>Total electricity</strong></td>
<td>3,800 – 4,300</td>
<td>7,400 – 8,700</td>
</tr>
<tr>
<td>Solar hot water</td>
<td>N/A</td>
<td>260</td>
</tr>
<tr>
<td>Heat pumps</td>
<td>N/A</td>
<td>4,430</td>
</tr>
<tr>
<td><strong>Total (heat)</strong></td>
<td></td>
<td>4,690</td>
</tr>
</tbody>
</table>
RE Resources Supply Curve

Cost per kWh, US$

GWh per year of generation

- Concessional
- SREP Financing + Commercial
- Commercial

SHPPs in Shirak Marz
SHPPs & biogas
Sisan Pass wind
Karakach wind
Solar PV*
Karkar geothermal (flash)
Poultry Farm biogas
Yerevan WWTP

Nub, LFG
## Present Situation

<table>
<thead>
<tr>
<th>Energy generating plants</th>
<th>Number</th>
<th>Capacity, MW</th>
<th>Annual energy generation, GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHPP</td>
<td>151</td>
<td>265</td>
<td>776</td>
</tr>
<tr>
<td>Wind</td>
<td>1</td>
<td>2,64</td>
<td>5,0</td>
</tr>
<tr>
<td>Biogas</td>
<td>1</td>
<td>0,835</td>
<td>5,9</td>
</tr>
<tr>
<td>Solar PV</td>
<td>1</td>
<td>0,01</td>
<td>0,015</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>154</td>
<td><strong>268,5</strong></td>
<td><strong>881.9</strong></td>
</tr>
</tbody>
</table>
Incentives

• Guaranteed purchase: 15 years
• Fixed tariff:
  • SHPP /natural water streams/: 21,061 AMD/kWh
  • SHPP /irrigation/: 14,039 AMD/kWh
  • SHPP /potable water/: 9.361 AMD/kWh
  • Wind: 37,007 AMD/kWh
  • Biomass: 40,338 AMD/kWh
• End-user tariff: 38 AMD/kWh; 28 AMD/kWh/ night
EE Investment Project

• Geothermal: $10 mln. resource confirmation
• Solar PV: $30 mln. 40 MW projects

In addition,

Solar PV
• ADB: $20 mln.
• WB: $10 mln.
• Commercial banks: $30 mln.
• Private sector: $30 mln.
• Geothermal: $95 mln. mixed.
Forest: 10%
Gas: 0%
Oil: 0%
Coal: 0%
Thank You

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