New ITS Component C
Following the OECD Plan to Climate Stabilization

BUILDING PARTNERSHIPS FOR ENERGY SECURITY

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INOGATE New ITS Project

Following the OECD Plan to Climate Stabilization

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Key Expert for Sustainable Energy

For INOGATE Ministerial Conference

2012
Overview

Section I. Two Problems

1. Climate Change
2. Energy Security

Section II. OECD Plan

Section III. Local Solutions
Section I

Two Problems

Problem #1: Climate Change

Problem #2: Energy Security
Problem #1: Climate Change

Scripps Inst. of Oceanography & OECD:

1. Atmospheric CO$_2$ level before industrial revolution: 280 ppm and stable (+/- 2%) 
2. Today: 393 ppm CO$_2$, 440 ppm all GHGs 
3. Increase: 2 ppm/yr

(Graph source: Gov. of Australia)
Climate Change, 21st century

From OECD:

- Beyond 450 ppm (all GHG)s: Tipping points
- Without intervention, will cross 450 ppm by 2030 (OECD).
Consequences

Beyond 450 ppm, > 50% probability:

• Average global atmospheric temperature will increase > 2°C (safe limit – Copenhagen Accord).

• Oceans begin releasing more CO₂ and absorbing less... beyond human ability to stop.

• Temperature will continue rising out of control.
The Cause

From IEA data

• Whole world burns 9,829 million tons - oil equivalent (Mtoe) of fossil fuel/yr.

• This produces about 48,500 Mtco$_2$e/yr.

• Annual increase: 700 Mtco$_2$e (1.45%).

• 3 biggest emitting sectors:
  – Electricity generation
  – Industry
  – Transport
By Country – Fossil Fuel

Calculated from IEA data:

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption (Mtoe/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>1.7</td>
</tr>
<tr>
<td>AZ</td>
<td>11.6</td>
</tr>
<tr>
<td>BY</td>
<td>26.1</td>
</tr>
<tr>
<td>GE</td>
<td>2.1</td>
</tr>
<tr>
<td>MD</td>
<td>2.5</td>
</tr>
<tr>
<td>UA</td>
<td>104</td>
</tr>
<tr>
<td>World</td>
<td>10,313</td>
</tr>
</tbody>
</table>

Largest are most industrialized countries.
By Country – Fossil Fuel

Calculated from IEA data:

<table>
<thead>
<tr>
<th>Country</th>
<th>Mtoe/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>KZ</td>
<td>74.2</td>
</tr>
<tr>
<td>KG</td>
<td>2.1</td>
</tr>
<tr>
<td>TJ</td>
<td>0.9</td>
</tr>
<tr>
<td>TM</td>
<td>21.3</td>
</tr>
<tr>
<td>UZ</td>
<td>43.1</td>
</tr>
</tbody>
</table>

Largest are most industrialized countries.
By Country - Emissions

Assuming emissions directly proportional to fossil fuel consumption, then by calculation:

<table>
<thead>
<tr>
<th>Country</th>
<th>Emissions (MtCO2e/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>7.9</td>
</tr>
<tr>
<td>AZ</td>
<td>54.8</td>
</tr>
<tr>
<td>BY</td>
<td>123</td>
</tr>
<tr>
<td>GE</td>
<td>9.8</td>
</tr>
<tr>
<td>MD</td>
<td>11.8</td>
</tr>
<tr>
<td>UA</td>
<td>488</td>
</tr>
<tr>
<td>World</td>
<td>48,500</td>
</tr>
</tbody>
</table>
By Country - Emissions

Assuming emissions directly proportional to fossil fuel consumption, then by calculation:

<table>
<thead>
<tr>
<th>Country</th>
<th>Emissions (MtCO2e/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KZ</td>
<td>349</td>
</tr>
<tr>
<td>KG</td>
<td>9.8</td>
</tr>
<tr>
<td>TJ</td>
<td>4.5</td>
</tr>
<tr>
<td>TM</td>
<td>100</td>
</tr>
<tr>
<td>UZ</td>
<td>203</td>
</tr>
</tbody>
</table>

Assumption is quite accurate in most cases.
Problem #2: Energy Security

• Most countries are energy-dependent.

• No country wants to be at the mercy of another for energy supply.

• Creates problems with national security, economy, sovereignty.
Section II

OECD Plan
OECD Plan, 2010-2100

Avoid tipping point (x) with 450 ppm limit.

Gradual reduction almost to carbon neutrality
OECD Plan, Step by Step

Simplified, shown by average in period

Four periods:
- 10 yr: 48,500 MtCO2e/yr
- 10 yr: 45,000 MtCO2e/yr
- 20 yr: 31,500 MtCO2e/yr
- 50 yr: 8,000 MtCO2e/yr
Solution: **Sustainable Development**

To stop global warming:

*Replace increases in fossil fuel with sustainable energy.*

- **Energy efficiency** stops unnecessary fossil fuel consumption.
- **Renewable energy sources** replace fossil fuel with carbon-neutral energy sources.
To accomplish OECD plan,

1. Change behavior.
2. Invest in technology.

The following slides present

1. A methodology to determine the right level of investment in sustainable energy technology.
2. A discussion about energy behavior.
What does technology cost?

- Prices vary widely.
- To demonstrate methodology, use median prices.
- To calculate for own country, use local prices.

<table>
<thead>
<tr>
<th>Typical unit costs</th>
<th>€/kWh</th>
<th>€/toe</th>
<th>€/tCO2e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency</td>
<td>0.025</td>
<td>300</td>
<td>60</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>0.085</td>
<td>1000</td>
<td>200</td>
</tr>
</tbody>
</table>

- Technologies cover all sectors
  - Energy
  - Industry
  - Buildings
  - Transportation
Calculate avoided emissions

Illustrative example:

• World needs to avoid increase of **700 MtCO₂e/yr**.

• Try method with 1/3 EE, 2/3 RES.

<table>
<thead>
<tr>
<th>MtCO₂e/yr</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>233</td>
<td>Energy efficiency</td>
</tr>
<tr>
<td>467</td>
<td>RES technologies</td>
</tr>
<tr>
<td>700</td>
<td>Total</td>
</tr>
</tbody>
</table>
# Calculate world cost

<table>
<thead>
<tr>
<th>Avoided emissions (MtCO2e/yr)</th>
<th>Unit cost (€/tCO2e)</th>
<th>Annual investment (billion €/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>233</td>
<td>60</td>
<td>14 EE</td>
</tr>
<tr>
<td>467</td>
<td>200</td>
<td>93 RES</td>
</tr>
<tr>
<td>700</td>
<td>x</td>
<td>107 World Cost</td>
</tr>
</tbody>
</table>

(Repeat every year as economy grows.)
Cost of World Business as Usual?

- Usual annual world energy infrastructure investment: \(13,400\) billion € (unofficial ITS estimate)

- Cost of annual SE upgrades: \(107\) billion €

- Most of SE upgrades will repay their investments with profit.
Section III

Local solutions
About GHG Growth Rates

• OECD model: 1.45%/yr GHG growth rate.
• But 2008 crisis disrupted all development.
• To demonstrate methodology we need *post-crisis* GHG growth.
• Assume local GHG growth = GDP growth.
• Use World Bank post-crisis GDP data.
EU investment example

- Baseline emissions: 6,100 MtCO$_2$e/yr
- GDP increase: 3.7%
- 3.7% GHG increase = 230 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>77 EE</td>
<td>x 60</td>
<td>= 5</td>
</tr>
<tr>
<td>153 RES</td>
<td>x 200</td>
<td>= 30</td>
</tr>
<tr>
<td>230 Total</td>
<td></td>
<td>= 35</td>
</tr>
</tbody>
</table>
Cost of EU Business as Usual?

• Usual annual EU cost of energy infrastructure investment: **2 600 billion €** (unofficial ITS estimate)

• Cost of SE annual upgrades: **35 billion €**

• Most of SE upgrades will repay their investments with profit.
Armenia Investment Example

- Baseline emissions: 7.9 MtCO$_2$e/yr
- GDP increase: 3.4%
- 3.4% GHG increase = 0.26 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09 EE</td>
<td>x 60</td>
<td>= 5</td>
</tr>
<tr>
<td>0.18 RES</td>
<td>x 200</td>
<td>= 35</td>
</tr>
<tr>
<td>0.27 Total</td>
<td></td>
<td>= 40</td>
</tr>
</tbody>
</table>
Cost of AM Business as Usual?

• Usual annual AM energy infrastructure investment: **2.8 billion €** (unofficial ITS estimate)

• Cost of SE annual upgrades: **0.04 billion €**

• GDP growth rate is good indicator of GHG increase in Armenia.
Azerbaijan Investment Example

- Baseline emissions: 55 MtCO$_2$e/yr
- GDP increase: 3%
- 3% GHG increase = 1.7 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6 EE</td>
<td>x 60</td>
<td>= 33</td>
</tr>
<tr>
<td>1.1 RES</td>
<td>x 200</td>
<td>= 219</td>
</tr>
<tr>
<td>1.7 Total</td>
<td></td>
<td>= 252</td>
</tr>
</tbody>
</table>
Cost of AZ Business as Usual?

• Usual annual AZ energy infrastructure investment: **8.4 billion €**
  (unofficial ITS estimate)

• Cost of SE annual upgrades: **0.25 billion €**

• Most of SE upgrades will repay their investments with profit.
Belarus Investment Example

- Baseline emissions: 123 MtCO$_2$e/yr
- GDP increase: 6.5%
- 6.5% GHG increase = 8.0 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7 EE</td>
<td>x 60</td>
<td>= 0.2</td>
</tr>
<tr>
<td>5.3 RES</td>
<td>x 200</td>
<td>= 1.1</td>
</tr>
<tr>
<td>8.0 Total</td>
<td></td>
<td>= 1.3</td>
</tr>
</tbody>
</table>
Cost of BY Business as Usual?

- Usual annual BY energy infrastructure investment: **16.9 billion €** (unofficial ITS estimate)
- Cost of SE annual upgrades: **1.3 billion €**
- Belarus may reach goal to reduce GDP energy intensity to level of advanced countries with similar climate in 14 years.
- 2010: DK - 0.1 Mtoe/billion €, steady BY - 0.6 Mtoe/billion €, falling 7%/yr
Georgia Investment Example

- Baseline emissions: 9.8 MtCO$_2$e/yr
- GDP increase: 6.6%
- 6.6% GHG increase = 0.65 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.22 EE</td>
<td>x 60</td>
<td>= 13</td>
</tr>
<tr>
<td>0.43 RES</td>
<td>x 200</td>
<td>= 86</td>
</tr>
<tr>
<td>0.65 Total</td>
<td></td>
<td>= 99</td>
</tr>
</tbody>
</table>
Cost of GE Business as Usual?

- Usual annual GE energy infrastructure investment: 3.5 billion €
  (unofficial ITS estimate)

- Cost of SE annual upgrades: 0.099 billion €

- After all SHPP exploited, need new method to hold down energy intensity while GDP grows.
Moldova Investment Example

- Baseline emissions: 11.8 MtCO$_{2}$e/yr
- GDP increase: 6.8%
- 6.8% GHG increase = 0.8 MtCO$_{2}$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_{2}$e/yr</th>
<th>€/tCO$_{2}$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.27 EE</td>
<td>x 60</td>
<td>= 16</td>
</tr>
<tr>
<td>0.53 RES</td>
<td>x 200</td>
<td>= 106</td>
</tr>
<tr>
<td>0.80 Total</td>
<td></td>
<td>= 122</td>
</tr>
</tbody>
</table>
Cost of MD Business as Usual?

- Usual annual MD energy infrastructure investment: 1.3 billion € (unofficial ITS estimate)

- Cost of SE annual upgrades: 0.12 billion €

- Before crisis, Moldova energy consumption was falling as GDP was rising.
Ukraine Investment Example

- Baseline emissions: 488 MtCO$_2$e/yr
- GDP increase: 4.7%
- 4.7% GHG increase = 22.7 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 EE</td>
<td>x 60</td>
<td>0.4</td>
</tr>
<tr>
<td>15.1 RES</td>
<td>x 200</td>
<td>3.0</td>
</tr>
<tr>
<td>22.7 Total</td>
<td></td>
<td>3.4</td>
</tr>
</tbody>
</table>
Cost of UA Business as Usual?

- Usual annual UA energy infrastructure investment: **25.6 billion €**
  (unofficial ITS estimate)

- Cost of SE annual upgrades: **3.4 billion €**

- UA needs to produce SREAP (energy action plan) for EnC.

- SREAP may be based on OECD plan.
Kazakhstan Investment Example

- Baseline emissions: 349 MtCO₂e/yr
- GDP increase: 7.4%
- 7.4% GHG increase = 25.8 MtCO₂e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO₂e/yr</th>
<th>€/tCO₂e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.6</td>
<td>EE</td>
<td>60</td>
</tr>
<tr>
<td>17.2</td>
<td>RES</td>
<td>200</td>
</tr>
<tr>
<td>25.8</td>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>
Cost of KZ Business as Usual?

- Usual annual KZ energy infrastructure investment: **26.4 billion €**
  (unofficial ITS estimate)

- Cost of SE annual upgrades: **3.9 billion €**

- Most of SE upgrades will repay their investments with profit.
Kyrgyzstan Investment Example

- Baseline emissions: 9.8 MtCO$_2$e/yr
- GDP increase: 2.8%
- 2.8% GHG increase = 0.28 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.09 EE</td>
<td>x 60</td>
<td>= 5.5</td>
</tr>
<tr>
<td>0.18 RES</td>
<td>x 200</td>
<td>= 37.0</td>
</tr>
<tr>
<td>0.28 Total</td>
<td></td>
<td>= 42.5</td>
</tr>
</tbody>
</table>
Cost of KG Business as Usual?

- Usual annual KG of energy infrastructure investment: **1.2 billion €**
  (unofficial ITS estimate)

- Cost of SE annual upgrades: **0.04 billion €**

- Most of SE upgrades will repay their investments with profit.
Tajikistan Investment Example

- Baseline emissions: 4.5 MtCO$_2$e/yr
- GDP increase: 7.0%
- 7.0% GHG increase = 0.3 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>million €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10 EE</td>
<td>x 60</td>
<td>= 6.3</td>
</tr>
<tr>
<td>0.21 RES</td>
<td>x 200</td>
<td>= 41.7</td>
</tr>
<tr>
<td>0.31 Total</td>
<td></td>
<td>= 48.0</td>
</tr>
</tbody>
</table>
Cost of TJ Business as Usual?

- Usual annual TJ energy infrastructure investment: 0.9 billion €
  (unofficial ITS estimate)

- Cost of SE annual upgrades: 0.05 billion €

- Most of SE upgrades will repay their investments with profit.
Turkmenistan Investment Example

- Baseline emissions: 100 MtCO$_2$e/yr
- GDP increase: 9.6%
- 9.6% GHG increase = 9.6 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>EE 60</td>
<td>0.2</td>
</tr>
<tr>
<td>6.4</td>
<td>RES 200</td>
<td>1.3</td>
</tr>
<tr>
<td>9.6</td>
<td>Total</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Cost of TM Business as Usual?

- Usual annual TM energy infrastructure investment: 1.1 billion € (unofficial ITS estimate)
- Cost of SE annual upgrades: 0.04 billion €
- Most of SE upgrades will repay their investments with profit.
Uzbekistan Investment Example

- Baseline emissions: 203 MtCO$_2$e/yr
- GDP increase: 8.4%
- 8.4% GHG increase = 17.0 MtCO$_2$e/yr
- Illustrative investment mix to avoid increase:

<table>
<thead>
<tr>
<th>MtCO$_2$e/yr</th>
<th>€/tCO$_2$e</th>
<th>billion €/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7 EE</td>
<td>x 60</td>
<td>= 0.3</td>
</tr>
<tr>
<td>11.3 RES</td>
<td>x 200</td>
<td>= 2.3</td>
</tr>
<tr>
<td>17.0 Total</td>
<td></td>
<td>= 2.6</td>
</tr>
</tbody>
</table>
Cost of UZ Business as Usual?

- Usual annual UZ energy infrastructure investment: **8.2 billion €**
  (unofficial ITS estimate)

- Cost of SE annual upgrades: **2.6 billion €**

- Most of SE upgrades will repay their investments with profit.
Return on Investment

Example:

- Georgian policy: Maximize use of all available hydropower resources.

  - Approximate ROI: 13%
  - Approximate IRR: 10%

- These numbers are acceptable in GE.

- Therefore, higher are more acceptable.
Installed Costs of SE Electricity Capacity

source: ITS informal research
Considerations

• Repeat investment *every year* to offset growth.

• Investments may come from
  – Domestic private industry
  – International private investors
  – International finance institutions
  – Municipal/regional budget
  – National budget

• Determine
  – investment potential by technology
  – unit cost by technology
  – energy consumption growth rate
Energy Security

• Although most investments will return more than they cost, others will not.

• Return is not the only criterion.

• Military budgets do not measure return.

• Governments spend whatever is necessary for their national security.

• Energy security is the same.
Every country’s goal: *Maximize national income!*  

- Every kWh not wasted at home is a kWh that can be sold abroad.
Changing Behavior

• Behavior is learned.

• Leaders can motivate society to stop waste.

• With motivation, people will
  – Close doors in winter.
  – Turn off lights by day.
  – Drive further on less petrol.

• Changing behavior costs LESS MONEY than the cheapest SE technology!
How to change behavior?

- Building codes, vehicle codes (policy)
- Energy audit requirements (policy)
- Public awareness campaigns
- Driver training to save fuel (and lives)
- Appliance demonstration centers
- Public school curricula (children influence parents)
Challenge: Strong Leadership

- Take your foot off the accelerator, the car stops.
- If leaders fall asleep, benefits stop.
- Policies need constant enforcement.
- Awareness raising must be continuous.
Summary

• Investments
  – Reduce GDP energy intensity
  – Increase productivity
  – Improve energy security
  – Reduce global warming
  – Create jobs

• Choose greatest ROIs first!

• Changing citizen behavior
  – Reduces investment cost
  – Requires long term commitment
Thank you for your attention!

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