The WADE Economic Model

World Alliance for Decentralized Energy (WADE)

www.localpower.org
What is Decentralized Energy (DE)?

Electricity production at the point of use, irrespective of size, fuel or technology – on-grid or off-grid:

- On-site renewable energy
- High efficiency CHP / cogeneration
- On-site industrial energy recycling
Decentralized Energy – The Main Choices

Small Gas Turbines

Reciprocating Engines

PV

Fuel Cells

Microturbines

Stirling Engines
The Key Question

- We all know: DE / CHP reduces emissions and is good for energy efficiency
- The most important question:
  - Is it also economically rational?
- The WADE Model was designed to answer that question
The DE Model – Why? and How?

- **Object**
  - To compare the costs of DE with that of central power in providing new electricity demand growth over the next 5 - 20 years
  - Also compares emissions and fuel use

- **Model ‘builds’ new capacity to meet demand growth and replace old plant**
  - Wide range of inputs determine what capacity is built and how much
  - Takes account of all system and network issues, including for example peak time network losses
    - Sufficient new central capacity needs to be developed to overcome peak network losses (often 15 – 20%)

- Can be applied to any country / region / city in the world
The DE Model – Expanding international application

- Past & current use:
  - Australia for Federal Government of Australia
  - China for UK Government (Foreign Office)
  - Delta State, Nigeria for State Government
  - EU-15 for EU DG-FER programme
  - Germany for Federal Gov’t of Germany
  - Ireland for Sustainable Energy Ireland
  - Ontario for Federal Government of Canada
  - Sri Lanka for European Commission
  - UK for Greenpeace UK
The DE Model – Inputs and Outputs

- Existing capacity and generation by technology
- Pollutant emissions by technology
- Heat rates, fuel consumption and load factor by technology
- Capital and investment costs by technology and for T&D
- Operation and maintenance (O&M) and fuel expenses by technology
- System growth properties
- Existing yearly capacity retirement by technology
- Future growth in capacity by technology

WADE Economic Model

- Capital Costs
- Retail Costs
- Fossil Fuel Use
- CO₂ and other Pollutant Emissions
Example Results - China
China – retail costs for new capacity to 2021

Retail Costs per KWh for Incremental 2021 Load

US$ Cents / KWh

% DE of Total Generation

- 100% CG / 0% DE
- 75% / 25%
- 50% / 50%
- 25% / 75%
- 0% CG / 100% DE

O&M of New Capacity
China – retail costs for new capacity to 2021

Retail Costs per KWh for Incremental 2021 Load

US$ Cents / KWh

% DE of Total Generation

100% CG / 0% DE  75% / 25%  50% / 50%  25% / 75%  0% CG / 100% DE

% DE of Total Generation

- O&M of New Capacity
- Fuel
China – retail costs for new capacity to 2021

Retail Costs per KWh for Incremental 2021 Load

- **US$ Cents / KWh**
  - 100% CG / 0% DE: 6
  - 75% / 25%: 6
  - 50% / 50%: 6
  - 25% / 75%: 6
  - 0% CG / 100% DE: 6

- **% DE of Total Generation**
  - 100% CG / 0% DE
  - 75% / 25%
  - 50% / 50%
  - 25% / 75%
  - 0% CG / 100% DE

Legend:
- **O&M of New Capacity**
- **Fuel**
- **Capital Amortization + Profit On New Capacity**
China – retail costs for new capacity to 2021

Retail Costs per KWh for Incremental 2021 Load

US$ Cents / KWh

% DE of Total Generation

- 100% CG / 0% DE
- 75% / 25%
- 50% / 50%
- 25% / 75%
- 0% CG / 100% DE

- O&M of New Capacity
- Capital Amortization + Profit On New Capacity
- Fuel
- T&D Amortization on New T&D

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China – capital cost for new capacity to 2021
**China – CO₂ emissions from new capacity to 2021**

**Added Annual CO₂ Emissions for Incremental Year 20 Load**

<table>
<thead>
<tr>
<th>% DE of Total Generation</th>
<th>100% CG / 0% DE</th>
<th>75% / 25% DE</th>
<th>50% / 50% DE</th>
<th>25% / 75% DE</th>
<th>0% CG / 100% DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million Metric Tonnes / Year</td>
<td>700</td>
<td>600</td>
<td>500</td>
<td>400</td>
<td>300</td>
</tr>
</tbody>
</table>

- Red: CO₂ emitted for added CG
- Blue: CO₂ emitted for added DE
China – fossil fuel use for new capacity to 2021

Added Annual Fossil Fuel Use for Incremental year 20 Load

Exajoules (EJ) of Fossil Fuel / Year

% DE of Total Generation

- 100% CG / 0% DE
- 75% / 25% DE
- 50% / 50% DE
- 25% / 75% DE
- 0% CG / 100% DE

- Total "New" CG Fuel Use
- Total "New" DE Fuel Use
The DE Model – tabulated summary results

<table>
<thead>
<tr>
<th>Impact of Meeting Demand Growth to 2021 with CG or DE</th>
<th>100% CG</th>
<th>100% DE</th>
<th>DE Savings</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Capital Cost</strong> (Capacity + T&amp;D)</td>
<td>1053</td>
<td>653</td>
<td>400</td>
<td>38%</td>
</tr>
<tr>
<td>Billsions of US$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Retail Cost ($c / kWh; new plant)</strong></td>
<td>9.97</td>
<td>7.16</td>
<td>2.81</td>
<td>28%</td>
</tr>
<tr>
<td><strong>Emissions (000 t):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOₓ</td>
<td>917</td>
<td>99</td>
<td>819</td>
<td>89%</td>
</tr>
<tr>
<td>SO₂</td>
<td>910</td>
<td>97</td>
<td>813</td>
<td>89%</td>
</tr>
<tr>
<td>PM10</td>
<td>48</td>
<td>20</td>
<td>28</td>
<td>58%</td>
</tr>
<tr>
<td><strong>CO₂ Emissions (Mt)</strong></td>
<td>739</td>
<td>322</td>
<td>416</td>
<td>56%</td>
</tr>
</tbody>
</table>
The DE Model – user friendly
Policy-oriented flexibility and limitless scenarios

- Users can change assumptions to meet policy objectives. Eg
  - CO₂ emission objectives
  - High renewable energy market share
  - High end use efficiency
  - Fossil fuel use caps or limits
  - High / low / zero nuclear options