China’s Energy and CO$_2$ Emission Scenario by 2050: A Policy Roadmap

Energy Research Institute, China
Framework of Integrated Policy Model for China (IPAC)

Energy demand and supply
- IPAC-SGM
  - Energy demand and supply
    - Price/investment
    - Economic impact
    - Medium/long-term analysis

Energy demand and supply
- IPAC-AIM/Global
  - Technology development
    - Environment impact
    - Technology policy

Energy demand and supply
- IPAC-Tech(Power/Transport)
  - Region analysis
    - Medium/short analysis
    - Energy demand and supply
    - Technology policy

Economic impact
- IPAC/SE, IPAC/EAlarm
  - IPAC/AIM/Local
    - Technology policy

Medium/long-term analysis
- IPAC-Emission
  - Environment industry
    - Pollutant emission
    - Medium/long-term analysis

Full range emission
- IPAC/AIM/MATERIAL
  - Energy demand and supply
    - Price, resource, technology
    - Medium-long term analysis
    - Economic impact

Short term forecast/energy early warning
- IPAC/Gains-Asia
  - Climate Model

Technology development
- IPAC/AIM/tech
  - Technology policy

Technology policy
- IPAC-health
  - AIM-air
Copenhagen Accord

To achieve the ultimate objective of the Convention to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius, on the basis of equity and in the context of sustainable development, enhance our long-term cooperative action to combat climate change.
Global Emission: 2 degree
Likely avoided temperature increase of IAM scenarios. Bar superimposed in 2020 shows expected emissions from the pledges.

Legend:
Emission levels consistent with a likely temperature increase (T) in the 21st century of:
- Purple: T > 5°C
- Dark red: 4°C < T < 5°C
- Red: 3°C < T < 4°C
- Orange: 2.5°C < T < 3°C
- Yellow: 2°C < T < 2.5°C
- Light green: T < 2°C

Range: range of pledge cases
Median: median range of pledge cases
Copenhagen Commitment: the GAP
CO2 Emission in China

- Baseline
- LC
- ELC
- 2Degree

Mt-CO2 vs. Year (2000-2050)

- Y-axis: Mt-CO2
- X-axis: Year

Legend:
- Baseline
- LC
- ELC
- 2Degree
Policies and Actions for Addressing Climate Change

• Improving Management Systems and Working Mechanisms
  • Carbon intensity target in 12th FYP was decomposed to all provinces
  • A target responsibility assessment system for local government

• Strengthening Strategic Studies and Plan Formulation
  • the overall target, phased tasks, implementation methods and safeguarding measures of low-carbon development by 2020, 2030 and 2050
  • National Plan for Addressing Climate Change (2013-2020)
  • Provincial Plans

• Promoting Legislation on Climate Change
  • have set up a leading group for drafting laws on addressing climate change
  • some respective laws have been issued, such as methods in Shanxi and Qinghai province and management in Shenzhen special economic zone
Policies and Actions for Addressing Climate Change

• Improving Relevant Policy Systems

• Work Division Scheme for the Work Plan for Controlling Greenhouse Gas Emissions during the 12th Five-Year Plan Period

• Issued a series of policy papers on addressing climate change, improve China’s policy system in this regard:
  • the Action Plan for Addressing Climate Change in Industry (2012-2020)
  • the National Plan for the Development of Science and Technology on Climate Change during the 12th Five-Year Plan Period
  • the Interim Measures on Low-carbon Products Certification Management
  • the Plans for Energy Development during the 12th Five-Year Plan Period
  • the Plans for the Development of Energy-Efficient and Environmental-Protection Industries during the 12th Five-Year Plan Period
  • the Suggestions on Speeding up the Development of Energy-Efficient and Environmental-Protection Industries
  • the Industrial Energy Efficiency during the 12th Five-Year Plan Period
  • the 2013 Implementation Plans for Industrial Energy Efficiency and Green Development
  • the Action Plan for Green Architecture
  • the National Eco-system Protection during the 12th Five-Year Plan Period
Recent Policies for Mitigation

• Economic structure optimization policies
  • NDRC’s industry policies
  • Investment control
  • Carbon tax/other taxes: within 12th Five Year
  • Emission trading: domestic, and international

• Energy structure
  • Clean utilization of fossil fuel: Natural gas (Shale gas etc.)
  • Renewable energy power generation oriented policies
    • New scenario by 2020: wind 250GW, solar: 50 to 80GW
    • More policies on pricing, especially on distributed power generation, feed-in tariff

• Energy efficiency policies
  • 12th FYP target: to the local government
  • Sector policies: including construction and transport
  • Improving energy efficiency standard and labeling scheme
  • Expanding energy conservative technologies and products

• Increasing forest carbon sinks
• Other GHG control: agriculture, non-CO2
What’s the future of China’s low carbon policy: key factors

• Economic structure optimization policies
• Energy efficiency policies
• Renewable energy/nuclear power generation oriented policies
• CCS
• Low carbon consumption/ lifestyle
• Land use emission reduction policies: so far relatively poor
• Can we pay for it? Cost and benefit
Investment by industrial sectors

- 建筑业
- 自来水的生产和供应业
- 煤气的生产和供应业
- 蒸汽热水生产供应业
- 电力生产供应业
- 其他工业
- 仪器仪表文化办公用机械
- 电气机械及器材
- 电子及通信设备制造业
- 交通运输设备制造业
- 普通机械、专用设备制造业
- 金属制品业
- 有色金属
- 黑色金属冶炼及压延加工业
- 非金属矿物制品业
- 橡胶制品业
- 塑料制品业
- 化学纤维制造业
- 医药制造业
- 化学原料及制品制造业
- 炼焦业
- 石油加工
- 印刷业记录媒介的复制，文教体育用品制造业
- 纸及纸制品业
- 木材加工及竹藤棕草制品业、家具制造业
- 服装皮革及其他纤维制品制造
- 纺织业
- 烟草加工业
- 食品饮料加工、制造业
- 非金属矿采选业，其他矿采选业，木材及竹材采运业
- 有色金属矿采选业
- 黑色金属矿采选业
- 天然气开采业
- 石油

亿元
## Products output in major sectors, Low Carbon and ELC

<table>
<thead>
<tr>
<th>Product</th>
<th>Unit</th>
<th>2005</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
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<tr>
<td>Steel</td>
<td>Million ton</td>
<td>355</td>
<td>610</td>
<td>570</td>
<td>440</td>
<td>360</td>
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<tr>
<td>Cement</td>
<td>Million ton</td>
<td>1060</td>
<td>1600</td>
<td>1600</td>
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<td>Glass</td>
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<td>399</td>
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<td>690</td>
<td>670</td>
<td>580</td>
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<td>Copper</td>
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<td>Ammonia</td>
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<td>8.51</td>
<td>16</td>
<td>16</td>
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<td>12</td>
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<tr>
<td>Ethylene</td>
<td>Million ton</td>
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<tr>
<td>Soda Ash</td>
<td>Million ton</td>
<td>14.67</td>
<td>23</td>
<td>24.5</td>
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<td>Casutic</td>
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<td>12.64</td>
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<td>Paper</td>
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<td>Fertilizer</td>
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<td>Aluminum</td>
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<td>Calcium</td>
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<td>10</td>
<td>8</td>
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## Unit energy use for key products, LCS Scenario

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<th>2050</th>
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<tr>
<td>Steel</td>
<td>Kgce/t</td>
<td>760</td>
<td>650</td>
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<td>Cement</td>
<td>Kgce/t</td>
<td>132</td>
<td>101</td>
<td>86</td>
<td>81</td>
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<td>Glass</td>
<td>Kgce/Weight Cases</td>
<td>24</td>
<td>18</td>
<td>14.5</td>
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<tr>
<td>Brick</td>
<td>Kgce/万块</td>
<td>685</td>
<td>466</td>
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<tr>
<td>Ammonia</td>
<td>Kgce/t</td>
<td>1645</td>
<td>1328</td>
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<td>1141</td>
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<td>Ethylene</td>
<td>Kgce/t</td>
<td>1092</td>
<td>796</td>
<td>713</td>
<td>693</td>
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<tr>
<td>Soda Ash</td>
<td>Kgce/t</td>
<td>340</td>
<td>310</td>
<td>290</td>
<td>284</td>
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<tr>
<td>Casutic</td>
<td>Kgce/t</td>
<td>1410</td>
<td>990</td>
<td>890</td>
<td>868</td>
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<tr>
<td>Calcium carbide</td>
<td>Kgce/t</td>
<td>1482</td>
<td>1304</td>
<td>1215</td>
<td>1201</td>
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<tr>
<td>Copper</td>
<td>Kgce/t</td>
<td>1273</td>
<td>1063</td>
<td>931</td>
<td>877</td>
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<tr>
<td>Aluminum</td>
<td>kWh/t</td>
<td>14320</td>
<td>12870</td>
<td>12170</td>
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<td>Paper</td>
<td>Kgce/t</td>
<td>1047</td>
<td>840</td>
<td>761</td>
<td>721</td>
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<tr>
<td>Electricity fossil fuel</td>
<td>Gce/kWh</td>
<td>350</td>
<td>305</td>
<td>287</td>
<td>274</td>
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### Transport, Low carbon scenario

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<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
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<tr>
<td>Family car ownership, per 100HH</td>
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<tr>
<td>Urban</td>
<td>3.37</td>
<td>14</td>
<td>36</td>
<td>65</td>
<td>77</td>
<td>78</td>
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<tr>
<td>Rural</td>
<td>0.08</td>
<td>0.2</td>
<td>8</td>
<td>38</td>
<td>70</td>
<td>90</td>
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<tr>
<td>Family car annual travel distance, km</td>
<td>9500</td>
<td>9500</td>
<td>9300</td>
<td>8635</td>
<td>8300</td>
<td>7480</td>
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<tr>
<td>Average engin size of family cars, litter</td>
<td>1.7</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.5</td>
<td>1.4</td>
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<tr>
<td>Fuel efficiency of car, L/100km</td>
<td>9.2</td>
<td>8.9</td>
<td>7.1</td>
<td>5.9</td>
<td>4.8</td>
<td>4.1</td>
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<tr>
<td>Share of MRT in total traffic volume, %</td>
<td>0.011</td>
<td>0.016</td>
<td>0.025</td>
<td>0.046</td>
<td>0.1</td>
<td>0.21</td>
</tr>
<tr>
<td>Share of Biofuel, %</td>
<td>1.10%</td>
<td>1.30%</td>
<td>4.1%</td>
<td>7.70%</td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td>Share of electric car, %</td>
<td>0%</td>
<td>0.12%</td>
<td>3.2%</td>
<td>6.80%</td>
<td>12.5%</td>
<td>19.8%</td>
</tr>
<tr>
<td>Share of fuel cell car, %</td>
<td>0%</td>
<td>0%</td>
<td>0.80%</td>
<td>1.60%</td>
<td>4.70%</td>
<td>7.90%</td>
</tr>
</tbody>
</table>
Rapid bus: using existing rapid road
Stockholm: bicycle is coming back
Low Carbon House in 2050: comfortable and energy saving

- **Solar PV**
  - Energy monitor system (Electric Appliance)
  - High efficiency lighting 【LED】
  - Super High Efficiency Air-Con
  - High insulation system
  - Fuel cell

- **Eco-Life style**
  - Solar energy for hot water and space heating
  - Reduction of 60% heating demand,普及率 70%
  - Appliances with high insulation system,
    减少50%照明需求，普及率 100%
  - Standby energy use
    降低1/3，普及率 100%

- **Public information**
  - Public consumption change
    减少10-20% 能源需求

- **Heat pump**
  - COP = 8, 普及率 100%
  - COP = 5, 普及率 30-70%

- **Low Carbon House**
  - Comfortable and energy saving
  - Planting on top

- **Standby energy use**
  - Reduce energy use, and higher life level
中国能效标识

生产者名称：合肥美菱股份有限公司
规格型号：BCD-186DHA

- 耗能低
- 中等
- 耗能高

耗电量（千瓦时/24小时）：0.25
冷藏室容积（升）：132
冷冻室容积（升）：54

依据国家标准：GB 12081.2-2008
Investment in Energy Industry in China

Energy Expenditures in China

Additional Investment in end use sectors in ELC

GDP Loss, %
By 2020, Wind 200GW to 250GW, Solar 50GW

Price: US$38000
Subsidy: US$15000 (Shanghai), no need to apply number plate (cost US$10000)
US$18000 (Beijing), no need to apply number plate (By Oct. 2012, 1.1 million people apply for 20000 number plates per month),

荣威E50的长/宽/高分别为3569/1551/1540mm，其定位为A00级紧凑型车。

荣威E50的长/宽/高分别为3569/1551/1540mm，其定位为A00级紧凑型车。
• Technology progress is much faster than our model says: learning curve effects

• High GDP growth could support low carbon development in China: all cost analysis in models are very small compared with GDP
  • By 2015, GDP in China could reach 75 trillion Yuan (in current value)
  • Newly added accumulated GDP is 450 Trillion Yuan
  • Cumulated GDP is 860 Trillion Yuan
  • All the investment need in all modeling study is much small

• China’s low carbon related technology manufacture is getting leading in the world: benefit for economy

• Local environment issues will be a very strong factor to go to clean production, nearly match with low carbon development
Policy roadmap: Super high efficiency air conditioner

- Efficiency Standard: COP, MEPS
- Government Planning
- Subsidy
## Major Constraints Factors Analysis

### Trend Analysis on EVs

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<tr>
<td><strong>Electric Vehicle (Evs)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Battery capacity (kWh)</td>
<td>16</td>
<td>24</td>
<td>48</td>
<td>80</td>
<td>112</td>
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<tr>
<td>Power price (yuan/kWh)</td>
<td>0.48</td>
<td>0.60</td>
<td>0.75</td>
<td>0.94</td>
<td>1.18</td>
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<td>Energy consumption (kWh/km)</td>
<td>0.18</td>
<td>0.13</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
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<tr>
<td>Energy cost (yuan/km)</td>
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<td>0.08</td>
<td>0.06</td>
<td>0.08</td>
<td>0.08</td>
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<tr>
<td>Battery capacity (USD/kWh)</td>
<td>43200</td>
<td>39067</td>
<td>30104</td>
<td>37694</td>
<td>41299</td>
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<td>Battery capacity (USD/car)</td>
<td>750</td>
<td>375</td>
<td>130</td>
<td>75</td>
<td>30</td>
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<tr>
<td>Battery cost per car (yuan/car)</td>
<td>380400</td>
<td>60300</td>
<td>41808</td>
<td>40200</td>
<td>22512</td>
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<td>Battery lifespan (years)</td>
<td>3.6</td>
<td>5</td>
<td>11</td>
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<td>Battery replacement (set/year)</td>
<td>4.1</td>
<td>2.8</td>
<td>1.4</td>
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<td>EVs lifetime battery cost (yuan/car)</td>
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<td>226728</td>
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<td>EVs lifetime energy cost (yuan/car)</td>
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<td>Annual cost (yuan/car)</td>
<td>30430</td>
<td>17720</td>
<td>8640</td>
<td>7042</td>
<td>5290</td>
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<td><strong>Internal Combustion Engine (ICE)</strong></td>
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<td>Fuel price (yuan/liter)</td>
<td>6.6</td>
<td>8.5</td>
<td>10.2</td>
<td>11.0</td>
<td>11.8</td>
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<td>Diesel fuel price (yuan/liter)</td>
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<td>8.3</td>
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<td>Energy consumption (L/km)</td>
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<td>Total mileage (km)</td>
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<td>Average mileage (km)</td>
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<td>Average mileage (km)</td>
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<td>Annual cost (Evs vs ICE)</td>
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### 电动汽车发展技术路线图

#### Electric Car Roadmap

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<td><strong>电动汽车发展目标</strong></td>
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<tr>
<td>电动汽车拥有量（万辆）</td>
<td>很少量</td>
<td>125</td>
<td>800</td>
<td>5000</td>
<td>9400</td>
</tr>
<tr>
<td>电动汽车年销售市场（万辆）</td>
<td>很少量</td>
<td>25</td>
<td>80</td>
<td>500</td>
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<td><strong>电动汽车技术进步</strong></td>
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<td>最高时速(km/h)</td>
<td>85</td>
<td>120</td>
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<td>续航距离(km)</td>
<td>112</td>
<td>130</td>
<td>200</td>
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<td>百公里耗电kWh/100km</td>
<td>16-18</td>
<td>13-14.3</td>
<td>10</td>
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<tr>
<td><strong>电池技术进步</strong></td>
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<tr>
<td>电池能量密度（Wh/kg，Wh/L）</td>
<td>90-125Wh/kg</td>
<td>150Wh/kg，150Wh/L</td>
<td>225Wh/kg，200Wh/L</td>
<td>500Wh/kg，460Wh/L</td>
<td>700Wh/kg</td>
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<tr>
<td>电池总能量（kWh）</td>
<td>16kWh</td>
<td>24kWh</td>
<td>40-48kWh</td>
<td>80-93kWh</td>
<td>112-124kWh</td>
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<tr>
<td>电池组寿命</td>
<td>1000次</td>
<td>1500次（5.4年）</td>
<td>3000</td>
<td>3800次（13年）</td>
<td>结合超级电容器</td>
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<td>电池成本$/kWh(元/kWh)</td>
<td>$750/kWh(502.5)</td>
<td>$375/kWh(251.3)</td>
<td>$107/kWh(717)</td>
<td>$75/kWh(503)</td>
<td>$30/kWh(201)</td>
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<tr>
<td><strong>充电站技术和发展进程</strong></td>
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<tr>
<td>充电站发展计划（国网和南网）</td>
<td>新建充电站325个；充电桩1.87万个。</td>
<td>新建充电站4325个；充电桩2.48万个。</td>
<td>新增充电站1万个，充电桩3万个。</td>
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<tr>
<td><strong>充电站系统建设进程</strong></td>
<td>常规充电（充电桩）设施建设，更换单电池方式试点。布局主要在居民小区或大型办公场所停车场。</td>
<td>常规充电为主，快充和更换电池示范。布局主要在机场、火车站、医院、购物中心、加油站等公共场所建快充和更换电池站。</td>
<td>常规充电为主，快充和更换电池为辅，形成充电站网络系统雏形。按电动车辆单次充电行驶里程，考虑充电站的布局和建设。太阳能充电站示范</td>
<td>完善充电站网络系统。太阳能充电站占有5-10%市场份额。移动式充电站得到应用。</td>
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### 电动汽车发展政策路线图建议

**Suggesting Policy Roadmap**

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<tr>
<td>战略和规划</td>
<td>组建领导机构</td>
<td>制定并发布国家电动汽车产业发展指导性政策和规划，整合大型电动汽车零部件产业集群</td>
<td>逐步形成产业链品牌，形成产融结合的创新体系</td>
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<tr>
<td>Strategic Plan</td>
<td>制定和落实电动汽车发展的相关政策和措施</td>
<td>研究电动汽车产业发展实施方案，实施电动汽车产业行动计划</td>
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<td>研发政策</td>
<td>组建产业联盟联合研发</td>
<td>对下一代新型动力电池材料、电机等开展基础性研究</td>
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<td>R&amp;D Policy</td>
<td>实施以电池原材料、制造技术和测试为导向的技术为重点的关键技术攻关项目，突破关键电池技术</td>
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<td>优惠政策</td>
<td>设立电动汽车发展专项基金</td>
<td>重点支持电池技术、特别是新一代电池技术的研发给予全经济激励政策</td>
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<td>Economic Stimulus</td>
<td>对电池等电动汽车主要零部件企业的自主创新研发费用给予补贴</td>
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<td>标准制定</td>
<td>尽快出台电动汽车国家标准和地方标准，完善电动汽车产业发展的标准体系</td>
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<td>Standards</td>
<td>规范动力电池和电机的型号、规格、接口，完善充电机、充电站标准</td>
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<td>充电系统建设</td>
<td>在2010年开始实施国I排放标准，2013、2014年分别实施国II、国III排放标准</td>
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<td>Infrastructure Building</td>
<td>研究充电设施市场需求，充电设施建设与电网，市政等基础设施建设的有机衔接</td>
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<td></td>
<td>提出充电系统建设的发展目标和实施方案(2010-2030)</td>
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<td>出台关于充电设施建设完善地方法规，包括：充电站、充电设施、充电网络的建设、运维、监管等政策</td>
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<td>对电网企业为重点的充电站系统建设给予投资优惠政策</td>
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<td>建立充电汽车用户提供充电服务的体系</td>
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Natural Gas Scenarios

- In 2010, Natural Gas use 107.2 BCM, while 12.2 BCM imported.
- In our low carbon scenario: by 2030, 370 BCM
- NEA’s planning: 260 BCM by 2015
POWER_BOX by Baosteel

2kW wind
10kW Solar PV

1.5m/s
Physical process
Renewable Energy

- 2009 Energy Bureau: Wind 80WG
- 2010 Energy Planning: Wind 150 GW, Solar 20GW by 2020
- Now: Wind 200GW to 300GW, Solar 50WG to 80 GW
- Based on the conclusion from Chinese Academy for Engineering, grid in China could adopt these renewable energy power generation in short term.
Thank you!

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