OPPORTUNITIES FOR RENEWABLE ENERGY AND CLEANTECH INDUSTRY IN TAIWAN

BUSINESS SWEDEN TAIPEI

May 2015
Taipei
OVER 98% OF ENERGY IS IMPORTED IN TAIWAN

BREAK DOWN OF SOURCE OF ENERGY SUPPLY, 2013

Import 98%
Indigenous 2%

HEAVY RELIANCE ON IMPORTED ENERGY THREATS ENERGY SECURITY AND INCREASE ECONOMIC RISK

SOURCE: 2013 ENERGY STATISTICS YEARLY BOOK, BUREAU OF ENERGY
ABOUT 70% OF ELECTRICITY CAPACITY IS FROM FOSSIL FUEL POWER PLANTS IN TAIWAN

INSTALLED ELECTRICITY CAPACITY BY SOURCE OF ENERGY, TAIPOWER, 2015, MARCH, TOTAL 40857MW

- Gas: 37%
- Coal: 26%
- Nuclear: 13%
- Renewable Energy: 10%
- Oil: 8%
- Hydro: 6%

FOSSIL FUEL BASED ELECTRICITY CAUSES CO2 EMISSION ISSUE IN TAIWAN

SOURCE: TAIPOWER, 2014/01/29
TAIWAN PROMULGATED RENEWABLE ENERGY ACT IN 2009 TO PROMOTE USE OF RENEWABLE ENERGY

SOURCE: ITRI, 2015
OFFSHORE WIND POWER AND SOLAR PV WILL BE KEY SOURCE OF RENEWABLE ENERGY IN 2030

TARGET OF INSTALLATION CAPACITY OF RENEWABLE ENERGY (2014) (MW)

<table>
<thead>
<tr>
<th>Source of energy</th>
<th>MW</th>
<th>2014</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>On shore</td>
<td>637</td>
<td>814</td>
<td>1,200</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td></td>
<td>Offshore</td>
<td>0</td>
<td>15</td>
<td>320</td>
<td>1,520</td>
<td>3,000</td>
</tr>
<tr>
<td>Hydro power</td>
<td></td>
<td>2,081</td>
<td>2,089</td>
<td>2,100</td>
<td>2,150</td>
<td>2,200</td>
</tr>
<tr>
<td>Solar PV</td>
<td></td>
<td>615</td>
<td>902</td>
<td>2120</td>
<td>4100</td>
<td>6200</td>
</tr>
<tr>
<td>Biomass</td>
<td></td>
<td>739</td>
<td>741</td>
<td>768</td>
<td>813</td>
<td>950</td>
</tr>
<tr>
<td>Geothermal</td>
<td></td>
<td>0</td>
<td>4</td>
<td>66</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4,074</td>
<td>4,569</td>
<td>6,574</td>
<td>9,933</td>
<td>13,750</td>
</tr>
</tbody>
</table>

GOVERNMENT AIMS TO DEVELOP LOCAL COMPETENT INDUSTRIES FOR RENEWABLE ENERGY

SOURCE: BOE, MOEA, 2014
GOOD POTENTIAL TO TURN AGRICULTURAL AND ANIMAL WASTE INTO BIOENERGY IN TAIWAN

ANNUAL AGRICULTURAL AND LIVE STOCK WASTE

<table>
<thead>
<tr>
<th>2014</th>
<th>Total production</th>
<th>Unit of waste</th>
<th>Total waste (M.T.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rice</td>
<td>1600 t M.T.</td>
<td>86Kg/M.T.</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>500 t M.T.</td>
<td>250Kg/M.T.</td>
</tr>
<tr>
<td></td>
<td>Pig</td>
<td>8 million</td>
<td>2.4Kg/Head/Day</td>
</tr>
<tr>
<td></td>
<td>Poultry</td>
<td>370 million</td>
<td>0.15Kg/Head/Day</td>
</tr>
</tbody>
</table>

CURRENT STATUS AND THE VISION

- Currently the agriculture waste is burned which result in air pollution
- Animal waste is used to produce fertilizer currently
- Strategy and Vision
  - Goal of 2030: 950 MW for biomass
  - Encouraging biogas development
  - Biomass waste incineration transformed to Energy Center with advanced technology to increase power yield
- Currently installed biomass power is total 740 MW
  - Municipal Solid Waste Incineration: 625 MW
  - Biogas: 19MW
  - Waste from industry and agriculture: 97MW

EXPERIENCE AND TECHNOLOGY REQUIRED TO TURN WASTE INTO BIOENERGY

SOURCE: COUNCIL OF AGRICULTURE, 2014
FOCUS ON FOUR GREEN INDUSTRIES DEVELOPMENT
SOLAR PV, WIND POWER, LED AND ENERGY ICT

Taiwan feasible renewable energy development
- Solar
- Wind
- Bioenergy
- Hydrogen and Fuel cell
- Ocean energy
- Geothermal

Green Energy Low Carbon Economy
- Renewable Energy
- Energy Saving

The dawning green energy industry program
(solar, wind, LED, biofuel, energy information, EV, fuel cell)

Taiwan possible ways of energy saving
- Lighting
- Air condition
- Transportation
- Energy management

Solar PV and LED
Export oriented with global competitiveness

Wind Power, Energy ICT
Industries with potential, the government push projects for development

Four key industries: Solar PV, Wind power, LED, Energy ICT

SOURCE: EXECUTIVE YUAN, 2014

BUSINESS SWEDEN 11 AUGUST, 2015 7
GOAL FOR PV IS FURTHER INCREASED TO 6,2 GW
“MILLION SOLAR ROOFS” PROJECTS IS KEY TO REACH THE GOAL

GOAL OF INSTALLED SOLAR PV, 2014

- Strategy: Gradual expansion/incentivizing roof-tops prior to ground installations
- Goal: 6,200 MW developed by 2030 (Roof-top 3,000 MW and Ground 3,200 MW)
- Buildings will be installed with PV panels through the incentives of feed-in tariffs
- BOE assists local governments on Solar Roof-top Program and Solar community Program to facilitate public participation

CREATE HOME TEST MARKET FOR EXPORT

SOURCE: ITRI 2014

BIPV: Building Integrated Photovoltaics
Left: National Museum of Marine Biology and Aquarium (104kWp)
Right: National Stadium, Kaohsiung, 1 MWp
Taiwan PV industry ranks number two worldwide for PV solar cell production with 8.3GW production volume in 2013 and 42% growth rate in 2013.

Taiwan has a complete PV industry supply chain. Develop high efficiency and low cost technology is the key strategy to increase competitiveness.

Supply chain of Taiwan PV industry:

- **Poly-Silicon**
  - 6 companies

- **Ingots/Wafer**
  - 15 companies

- **Solar Cell**
  - 18 companies
  - Wafer-based solar cell
    - Multi-Si, Mono-Si, GaAs
  - Thin Film Solar Cell
    - a-Si/μ-Si, CIGS,
    - Dye Sensitized solar cell
  - CPV

- **PV Module**
  - 17 companies

- **PV System Installation**
  - > 100 companies

**SOURCE:** INDUSTRY TECHNOLOGY RESEARCH INSTITUTE, 2014
TOP 3 SOLAR CELL MANUFACTURERS ACCOUNTS FOR 55% OF TAIWAN PRODUCTION VOLUME IN 2013

BREAKDOWN OF PRODUCTION VOLUME BY TAIWANESE SOLAR CELL MANUFACTURERS IN 2013

- Motech: 20%
- Neo Solar Power: 19%
- Gintech Energy: 17%
- Solar Tech Energy: 7%
- Topcell Solar International: 7%
- Inventec Solar: 5%
- Tainergy Tech: 5%
- Taiwan Solar Energy: 4%
- Other: 16%

SOURCE: ENERGY TREND, 2014
3GW OF OFFSHORE WIND POWER BY 2030
- GOVERNMENT INCENTIVE PROGRAM TO CREATE THE MARKET

ABOUT THE GOVERNMENT INCENTIVE PROGRAM

- The incentive program subsidize 2 cases (4 platforms) from private sector and 1 case (2 platform) from a state-owned company
- The six demo platforms needs to be complete by 2016 and three demo parks needs to be complete by 2020
- Two private companies Fuhai Windfarm and Formosa Wind were awarded as winner of the government scheme project and also the state-owned utility Taipower

PLANNED LOCATIONS FOR THE OFFSHORE WIND

Formosa Wind (30 turbines planned with 108 MW)

Taipower (state-owned utility) plan 20-30 turbines for phase I with 110 MW

Fuhai windfarm corp (52 turbines planned, 2 parks above 100MW).

SOURCE: BOE
TAIWAN WILL HAVE CAPACITY TO PRODUCE 5MW OFFSHORE WIND TURBINE

TAIWAN SUPPLIERS FOR THE WIND TURBINES

DEVELOPMENT OF THE INDUSTRY

- The onshore wind power turbines are mainly imported in Taiwan
- Taiwan company TECO has gradually developed as wind turbine system manufacturers which has the ability for onshore 2M wind turbine production
- Taiwan government would like to push local industry for offshore wind development. TECO will has a Joint Venture company with China Steel Machinery with focus on offshore wind turbine development and will test a 5MW offshore wind turbine in 2015
- Taiwan has needs to set up the indigenous working fleet for offshore wind park. The ship building company CSBC and China Steel Group has entered the marine engineering businesses to support government policy
- Small and Medium sized companies develop own brand wind turbines for export market

GOAL IS TO DEVELOP LOCAL COMPETENCE FOR MANUFACTURE, OPERATION AND MAINTENANCE

SOURCE: BUSINESS SWEDEN TAIPEI COMPILE
LED DEVICE AND MODULE PRODUCTION IS TAIWAN’S STRENGTH

The local government promotion of the local LED lighting market and also the global demand for LED lighting keeps drives the market.

Production value of Taiwan LED industry is about USD 7.3 billion in 2013. The growth rate of Taiwan is expected to be 9% in 2014.

Taiwan LED device production ranked world number 3 (23% of global market share) and module ranked global number 2 (26% of global market share)

Taiwan LED industry is weak at the LED lighting and LED automotive lighting and lack of own lighting brand and channel experience

BECOME GLOBAL KEY LED DEVICE AND MODULE SUPPLIER AND TO BUILD WORLDWIDE CHANNEL FOR LIGHTING

SOURCE: INDUSTRY TECHNOLOGY RESEARCH INSTITUTE, 2015/01

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ICT STRENGTH GIVES TAIWAN GOOD BASE TO ENTER ENERGY ICT MARKET

Focus on AMI system and energy management and expand export market

2013
Production value: USD600 million
Energy saving: 100m KWh
10,000 smart meter installation
Demo project for AMI system

2016
Production value: USD1,100 million
Energy saving: 330m KWh
100,000 smart meter installation
MDMS development

2020
Production value: USD2,200 million
Energy saving: 790m KWh
Virtual power plant test
Export the solution

AMI and Energy management solution export

LACK OF SYSTEM INTERGRATION EXPERIENCE IS THE CHALLENGE FOR TAIWAN
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