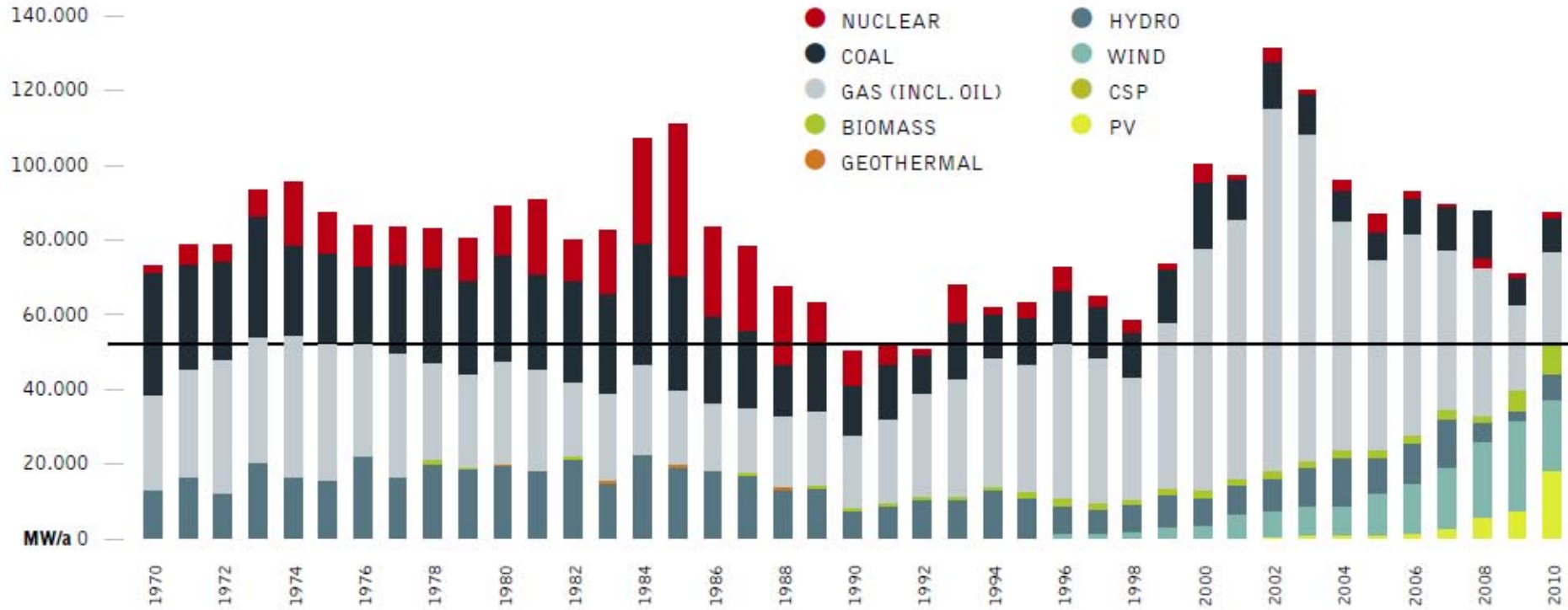


Session 2B

Technology and Business features

global power plant market 1970-2010, excluding china



- NUCLEAR
- COAL
- GAS (INCL. OIL)
- BIOMASS
- GEOTHERMAL
- HYDRO
- WIND
- CSP
- PV

source PLATTS, IEA, BREYER, TESKE.

Global annual power plant market - the past 40 years and a projection of the next 40 years

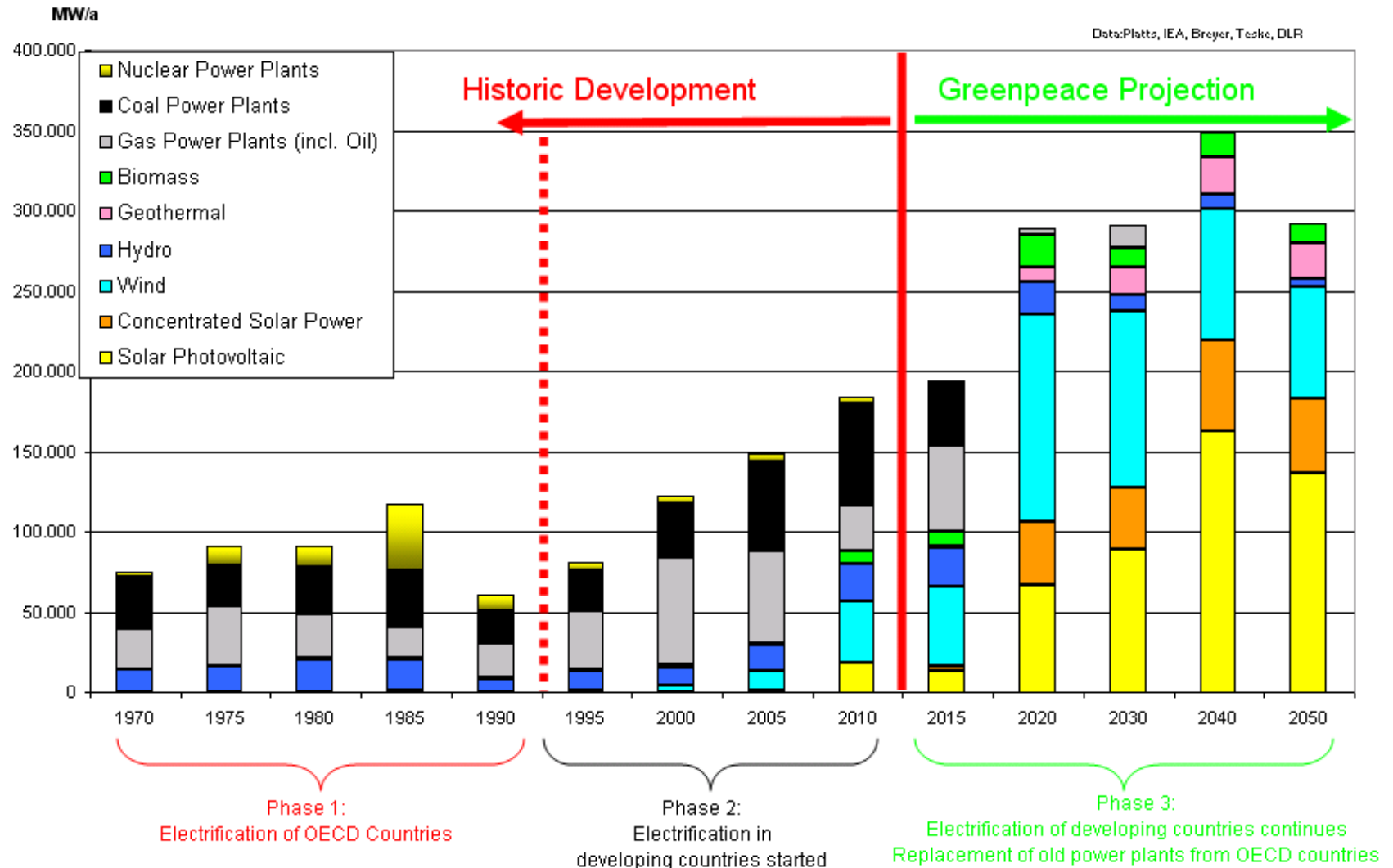
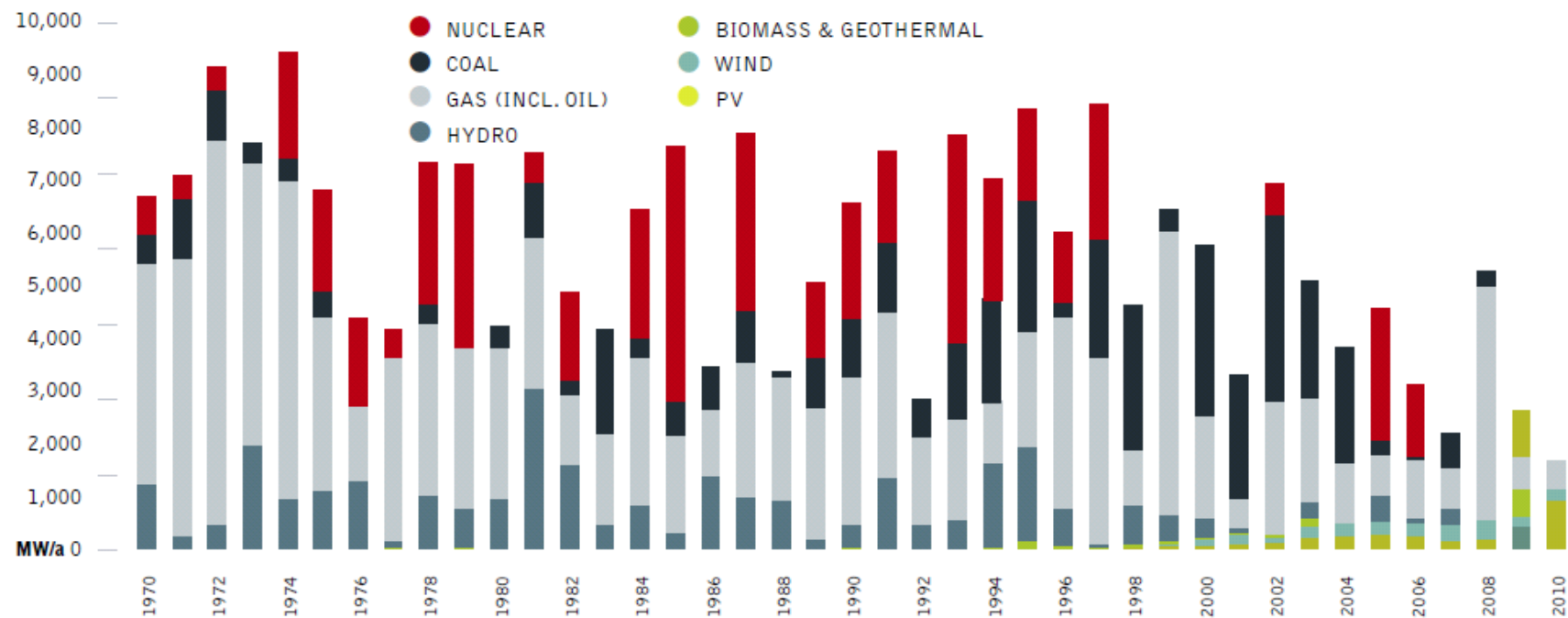


figure 6.7: japan: annual power plant market 1970-2010



source PLATTS, IEA, BREYER, TESKE.

table 0.1: japan - overview energy [r]evolution immediate nuclear energy phase out

| NUCLEAR PHASE-OUT 2012: REPLACEMENT STRATEGY | | | | | | | | | | |
|--|------------------------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|-------------|-------------|
| | UNIT | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| NUCLEAR GENERATION REPLACEMENT | TWh/a | 135 | 135 | 135 | 135 | 121.0 | 106.9 | 92.66 | 78.3 | 63.8 |
| Increased power generation from gas power plants via higher capacity factors | TWh | 98.0 | 90.8 | 83.7 | 76.3 | 64.1 | 53.1 | 42.3 | 31.7 | 17.3 |
| Required capacity factor for gas power plants | h/a | 7,565 | 7,335 | 7,115 | 6,900 | 6,780 | 6,675 | 6,570 | 6,465 | 6,290 |
| Annual demand reduction 1.7% per year (Instead of 1% per year) | TWh/a | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Wind electricity to replace nuclear | TWh/a | 5.8 | 11.7 | 17.7 | 23.5 | 21.8 | 18.8 | 15.3 | 11.4 | 12.0 |
| PV electricity to replace nuclear | TWh/a | 1.2 | 2.5 | 3.8 | 5.0 | 5.0 | 5.1 | 5.1 | 5.1 | 4.5 |
| Total additional Wind + PV generation | TWh/a | 7.0 | 14.2 | 21.5 | 28.6 | 26.8 | 23.9 | 20.4 | 16.5 | 16.4 |
| NUCLEAR CAPACITY REPLACEMENT | GW | 19.3 | 19.3 | 19.3 | 19.3 | 17.2 | 15.1 | 13.1 | 11.0 | 8.9 |
| Annual wind market | GW | 5.0 | 5.0 | 5.0 | 5.0 | 6.1 | 6.1 | 6.1 | 6.1 | 6.1 |
| Total wind capacity | GW | 8.3 | 13.3 | 18.3 | 23.3 | 29.4 | 35.6 | 41.7 | 47.9 | 56.0 |
| Annual PV market | GW | 5.0 | 5.0 | 5.0 | 5.0 | 6.7 | 6.7 | 6.7 | 6.8 | 6.8 |
| Total PV capacity | GW | 8.9 | 13.9 | 18.9 | 23.9 | 30.6 | 37.3 | 44.1 | 50.8 | 57.0 |
| Total additional Wind + PV capacity | GW | 10.0 | 10.0 | 10.0 | 10.0 | 12.9 | 12.9 | 12.9 | 12.9 | 12.9 |
| Annual CO ₂ emissions | million T CO ₂ /a | 1,267 | 1,261 | 1,254 | 1,247 | 1,171 | 1,095 | 1,018 | 942 | 866 |
| CO ₂ emissions compared to 1990 levels | % | 111% | 110% | 110% | 109% | 102% | 96% | 89% | 82% | 76% |

figure 1.5: japan - development of electricity generation structure under three scenarios

(REFERENCE, ENERGY [R]EVOLUTION AND ADVANCED ENERGY [R]EVOLUTION) [“EFFICIENCY” = REDUCTION COMPARED TO THE REFERENCE SCENARIO]

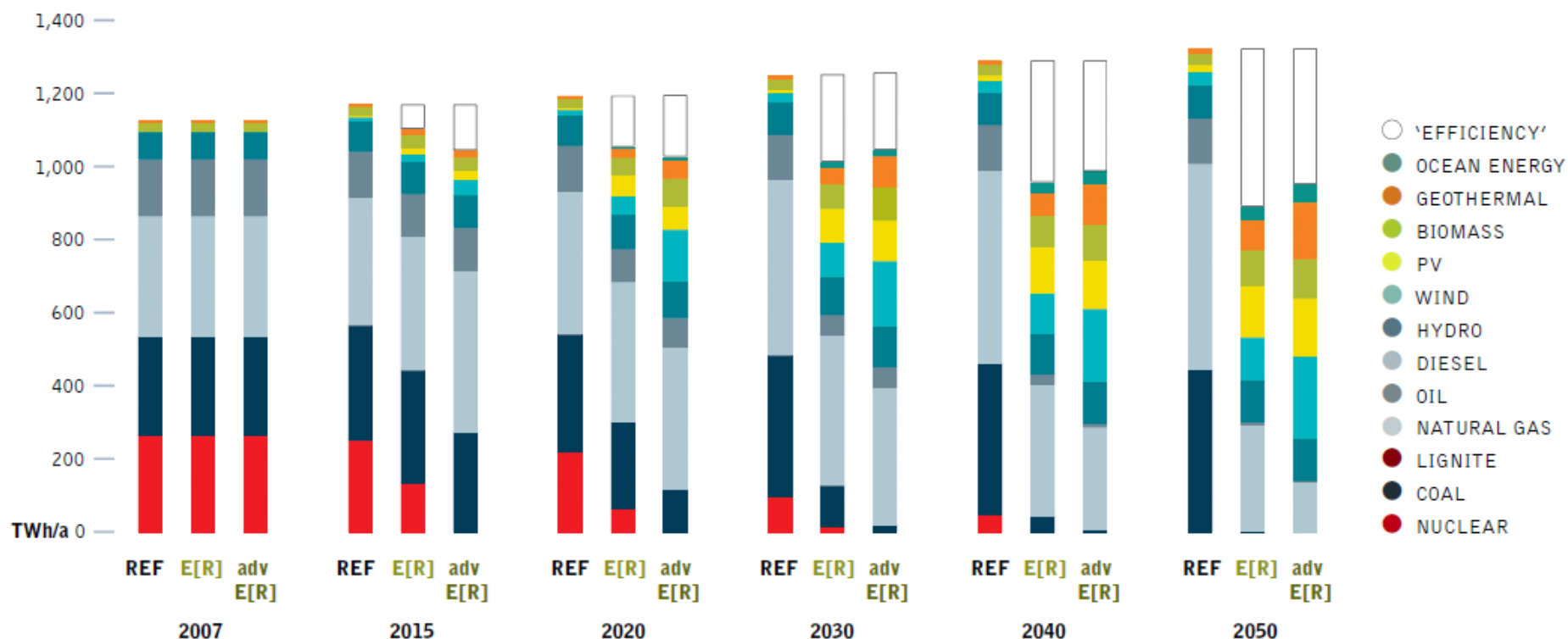


table 1.3: japan - projection of renewable electricity generation capacity under both energy [r]evolution scenarios

IN GW

| | | 2007 | 2020 | 2030 | 2040 | 2050 |
|--------------|----------------------|-----------|------------|------------|------------|------------|
| Hydro | E[R] | 19 | 23 | 25 | 26 | 27 |
| | advanced E[R] | 19 | 24 | 26 | 27 | 27 |
| Biomass | E[R] | 3 | 7 | 10 | 13 | 17 |
| | advanced E[R] | 3 | 13 | 14 | 15 | 18 |
| Wind | E[R] | 2 | 23 | 34 | 38 | 37 |
| | advanced E[R] | 2 | 51 | 64 | 68 | 71 |
| Geothermal | E[R] | 1 | 3 | 6 | 9 | 11 |
| | advanced E[R] | 1 | 7 | 12 | 16 | 22 |
| PV | E[R] | 0 | 51 | 80 | 104 | 113 |
| | advanced E[R] | 0 | 53 | 96 | 112 | 125 |
| Ocean energy | E[R] | 0 | 2 | 5 | 8 | 10 |
| | advanced E[R] | 0 | 3 | 5 | 10 | 14 |
| Total | E[R] | 24 | 110 | 161 | 199 | 215 |
| | advanced E[R] | 24 | 152 | 218 | 248 | 277 |

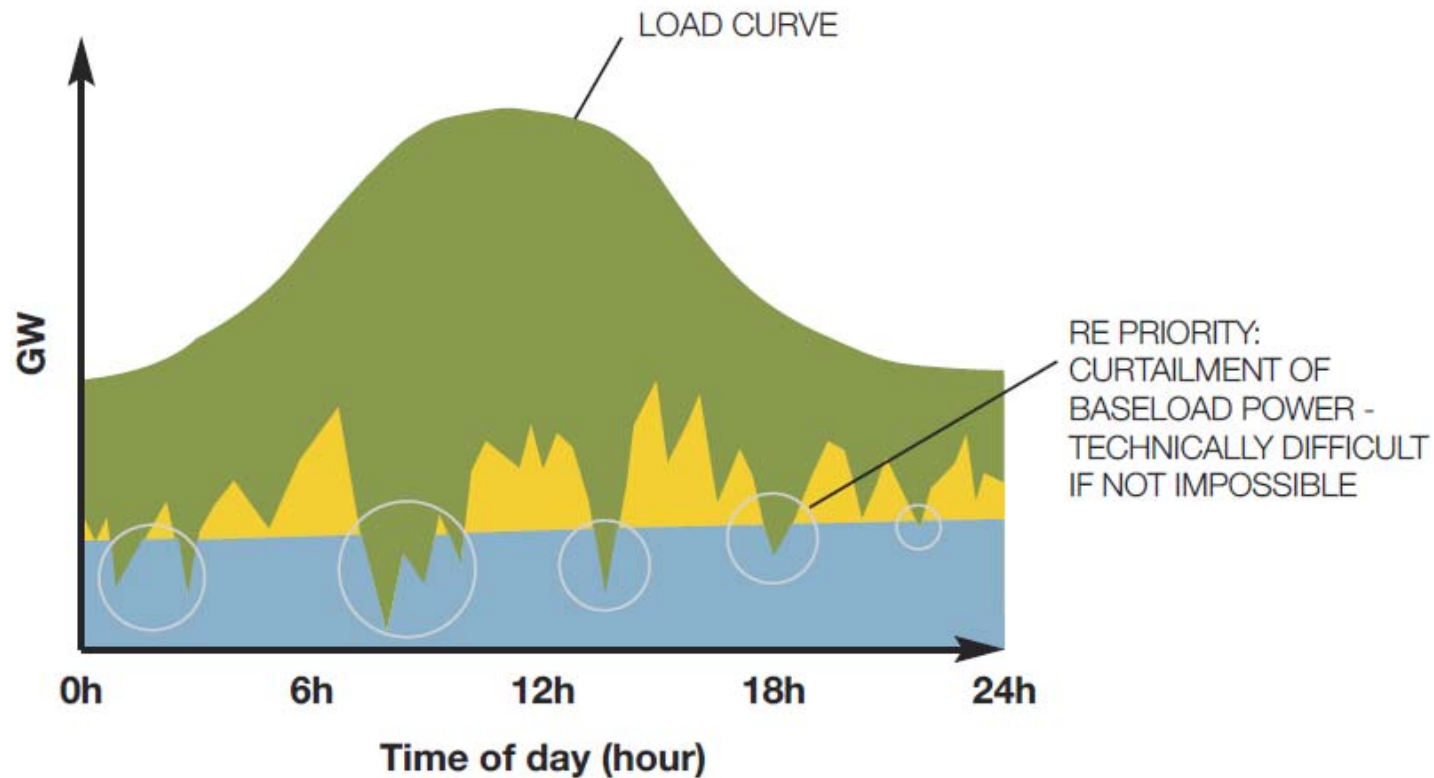
table 1.4: japan - fuel cost savings and investment costs under three scenarios

| INVESTMENT COST | DOLLAR | 2011-2020 | 2021-2030 | 2031-2040 | 2041-2050 | 2011-2050 | 2011-2050 AVERAGE PER YEAR |
|---|--------------|------------|------------|------------|--------------|--------------|----------------------------------|
| JAPAN (2011) DIFFERENCE E[R] VERSUS REF | | | | | | | |
| Conventional (fossil & nuclear) | billion \$ | -29 | -15 | -81 | -91 | -217 | -5.0 |
| Renewables | billion \$ | 171 | 71 | 124 | 74 | 440 | 10.2 |
| Total | billion \$ | 142 | 56 | 43 | -18 | 223 | 5.2 |
| JAPAN (2011) DIFFERENCE ADV E[R] VERSUS REF | | | | | | | |
| Conventional (fossil & nuclear) | billion \$ | -30 | -56 | -82 | -90 | -257 | -6.0 |
| Renewables | billion \$ | 280 | 84 | 175 | 109 | 648 | 15.1 |
| Total | billion \$ | 251 | 28 | 94 | 19 | 391 | 9.1 |
| CUMULATED FUEL COST SAVINGS | | | | | | | |
| SAVINGS E[R] CUMULATED IN € | | | | | | | |
| Fuel oil | billion \$/a | 24 | 105 | 175 | 223 | 526 | 12 |
| Gas | billion \$/a | -7 | 59 | 200 | 422 | 674 | 16 |
| Hard coal | billion \$/a | 14 | 99 | 186 | 244 | 543 | 0 |
| Total | billion \$/a | 31 | 263 | 561 | 889 | 1,744 | 41 |
| SAVINGS ADV E[R] CUMULATED IN € | | | | | | | |
| Fuel oil | billion \$/a | 29 | 113 | 194 | 245 | 581 | 13.5 |
| Gas | billion \$/a | -57 | 84 | 301 | 649 | 978 | 22.7 |
| Hard coal | billion \$/a | 39 | 155 | 222 | 256 | 671 | 15.6 |
| Total | | 12 | 352 | 717 | 1,150 | 2,231 | 51.9 |

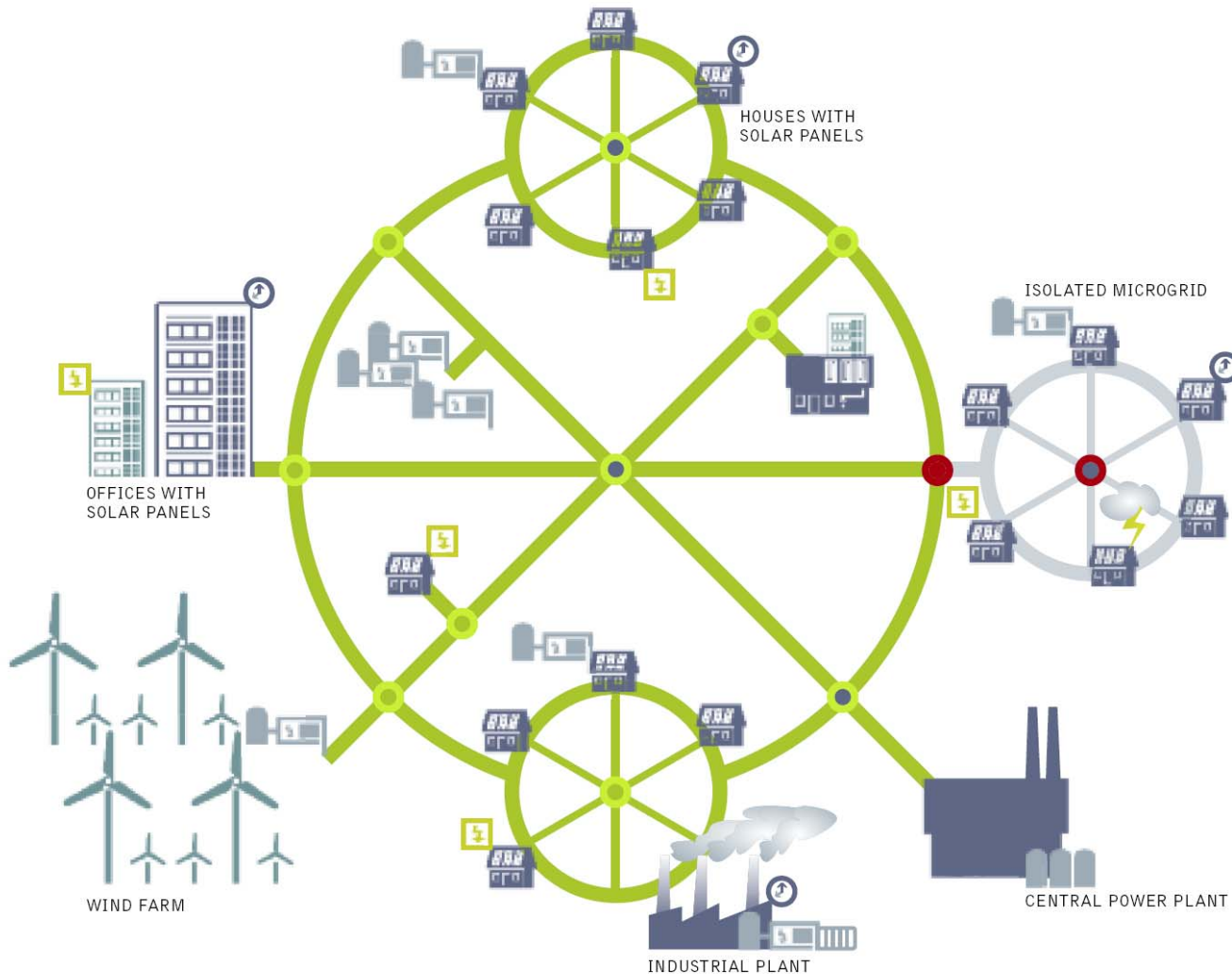
Reality Check: Need Infrastructure

Electricity Grid

- Technology Choices: „Base-load“ versus „Flexible Generation“
- Decentralized Generation versus Centralized Generation



smart-grid vision for the energy [r]evolution



Session 1D

Electric Utility Regulation and Markets

smart-grid vision for the energy [r]evolution

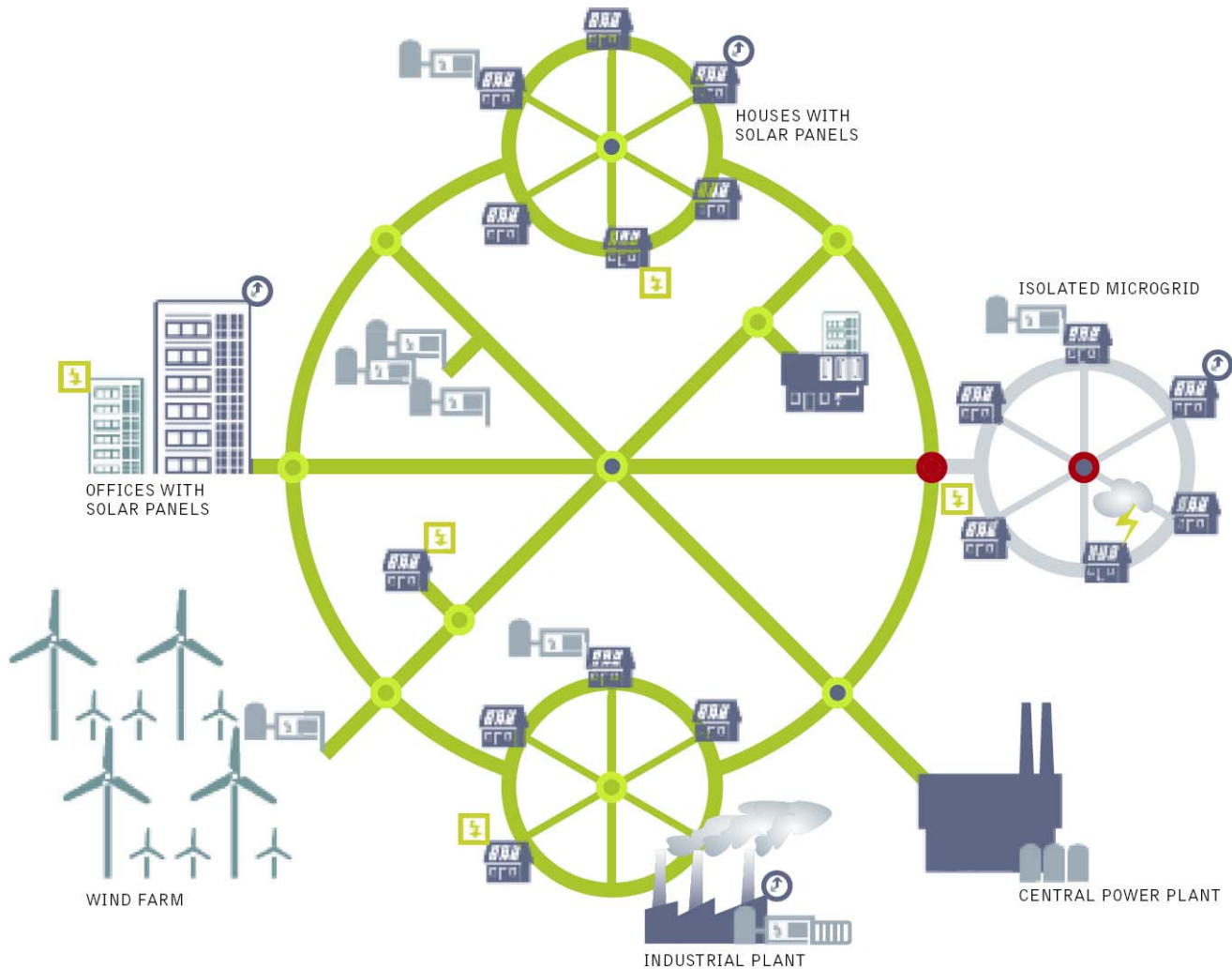


table 4.1: power plant value chain

| TASK & MARKET PLAYER | (LARGE SCALE) PROJECT GENERATION | INSTALLATION DEVELOPMENT | PLANT OWNER | OPERATION & MAINTANANCE | FUEL SUPPLY | DISTRIBUTION | SALES |
|--|--|--------------------------|--|-------------------------|---------------------------------|--|-------|
| STATUS QUO | Very few new power plants + central planning | | large scale generation in the hand of few IPP 's & utilities | | global mining operations | grid operation still in the hands of utilities | |
| MARKET PLAYER | | | | | | | |
| Utility | | | | | | | |
| Mining company | | | | | | | |
| Component manufacturer | | | | | | | |
| Engineering companies & project developers | | | | | | | |
| ENERGY [R]EVOLUTION POWER MARKET | many smaller power plants + decentralized planning | | large number of players e.g. IPP 's, utilities, private consumer, building operators | | no fuel needed (except biomass) | grid operation under state control | |
| MARKET PLAYER | | | | | | | |
| Utility | | | | | | | |
| Mining company | | | | | | | |
| Component manufacturer | | | | | | | |
| Engineering companies & project developers | | | | | | | |

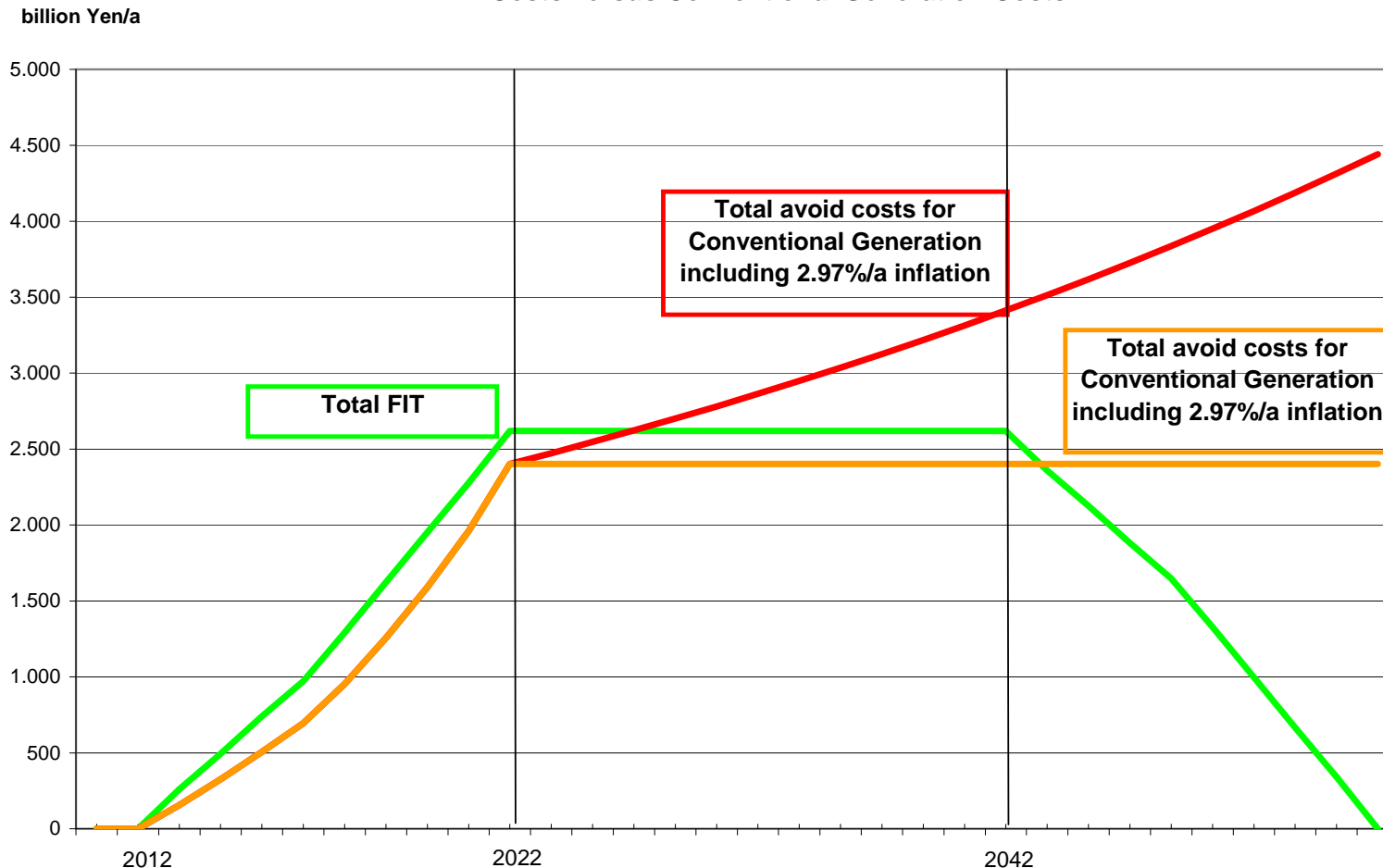
Session FIT

Feed-in Tariff Law for Japan

| Technology | Investment Costs | Financing Costs | | | | | | | | FIT | |
|---------------------------|---|--|--------------------|-----------------|-------------|-------------------------|-----------------|--------------------------|-------------|-----------------|-----------|
| Classification | Installed and connected to the grid - global average market price (example) | Credit share of the overall investment | Upfront Investment | Financial costs | Total Costs | Operation & Maintenance | Capacity Factor | Full Load Hours per year | FIT Payment | Required tariff | |
| Solar photovoltaic | | Input | | | | Input | calc | 8760 | Input | | |
| | [Yen/kW] | [%] | [Yen] | [Yen] | [Yen] | [%/a] | [Yen/a] | [%/a] | [h/a] | [a] | [Yen/kWh] |
| < 30 kW | 274.833 | 70 | 82.450 | 127.935 | 402.768 | 2,00% | 8.055 | 19 | 1650 | 20 | 17 |
| < 100 kW | 247.350 | 70 | 74.205 | 115.141 | 362.491 | 2,00% | 7.250 | 19 | 1650 | 20 | 15 |
| > 100kW | 197.880 | 70 | 59.364 | 92.113 | 289.993 | 2,00% | 5.800 | 19 | 1650 | 20 | 12 |
| Wind | | | | | | | | | | | |
| onshore | 148.410 | 70 | 44.523 | 69.085 | 217.495 | 2,00% | 4.350 | 20 | 1750 | 20 | 9 |
| offshore | 329.800 | 70 | 98.940 | 69.085 | 398.885 | 2,00% | 7.978 | 40 | 3500 | 20 | 8 |
| floating offshore | 439.733 | 70 | 131.920 | 69.085 | 508.818 | 2,00% | 10.176 | 51 | 4500 | 20 | 8 |
| | | 0 | | | | | | | | | |
| Small Hydro | | | | | | | | | | | |
| < 500 kW | 439.733 | 70 | 131.920 | 204.696 | 644.429 | 2,00% | 12.889 | 51 | 4500 | 20 | 10 |
| < 10 MW | 384.767 | 70 | 115.430 | 179.109 | 563.875 | 2,00% | 11.278 | 51 | 4500 | 20 | 9 |
| < 20 MW | 351.787 | 70 | 105.536 | 163.757 | 515.543 | 2,00% | 10.311 | 51 | 4500 | 20 | 8 |
| < 50 MW | 329.800 | 70 | 98.940 | 153.522 | 483.322 | 2,00% | 9.666 | 51 | 4500 | 20 | 8 |
| > 50 MW | 329.800 | 70 | 98.940 | 153.522 | 483.322 | 2,00% | 9.666 | 51 | 4500 | 20 | 8 |
| | | 0 | | | | | | | | | |
| Geothermal | | | | | | | | | | | |
| < 5 MW | 1.319.200 | 70 | 395.760 | 614.087 | 1.933.287 | 2,00% | 38.666 | 68 | 6000 | 20 | 23 |
| <10 MW | 1.209.266 | 70 | 362.780 | 562.913 | 1.772.180 | 2,00% | 35.444 | 68 | 6000 | 20 | 21 |
| < 20 MW | 1.099.333 | 70 | 329.800 | 895.544 | 1.994.877 | 2,00% | 39.898 | 68 | 6000 | 20 | 23 |
| > 20 MW | 989.400 | 70 | 296.820 | 460.566 | 1.449.965 | 2,00% | 28.999 | 68 | 6000 | 20 | 17 |
| | | 0 | | | | | | | | | |
| Bio energy | | | | | | | | | | | |
| < 150 kW | 384.767 | 70 | 115.430 | 179.109 | 563.875 | 2,00% | 11.278 | 57 | 5000 | 20 | 8 |
| < 500 kW | 357.283 | 70 | 107.185 | 166.315 | 523.599 | 2,00% | 10.472 | 57 | 5000 | 20 | 7 |
| < 5 MW | 329.800 | 70 | 98.940 | 153.522 | 483.322 | 2,00% | 9.666 | 57 | 5000 | 20 | 7 |
| 5 MW - 20 MW | 302.317 | 70 | 90.695 | 140.728 | 443.045 | 2,00% | 8.861 | 57 | 5000 | 20 | 6 |

FIT versus Conventional generation costs

FIT Costs versus Conventional Generation Costs



Extra Costs per kWh

With an average consumption per household of 4000kWh/a this would mean that each house hold will not pay more than 2500 – 3000 Yen/a extra to finance the FIT program.

