the advanced energy [r]evolution

A SUSTAINABLE ENERGY OUTLOOK FOR JAPAN

Summary

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The Energy [R]evolution

Greenpeace's Advanced Energy [R]evolution report presents three possible scenarios for Japan's energy future: a Reference scenario to show the business-as-usual path, an Energy [R]evolution scenario detailing a nuclear phase-out and switch to renewables, and an Advanced Energy [R]evolution scenario, created in the aftermath of the nuclear crisis, showing how Japan can make a rapid switch to a safe, renewable future while closing all reactors permanently in 2012.

The 'Reference Scenario' is based on the International Energy Agencies (IEA) World Energy Outlook 2009, while the basic Energy [R]evolution scenario shows predictions from the last Energy [R]evolution scenario (published in 2007) to highlight what was possible in Japan before the March 11 disaster. As we are now in a crisis situation with all of Japan's nuclear plants closing by May 2012, the Advanced Energy [R]evolution scenario includes an emergency plan until 2020, to show that these plants can be closed permanently without negative impact. Both Energy [R]evolution scenarios were calculated by the German Aerospace Center (DLR) with support from the Institute for Sustainable Energy Policies (ISEP).

The Advanced Energy [R]evolution scenario is based on a detailed renewable energy resource assessment from Japan's Ministry of Environment published in April 2011. It has used the technical potentials for wind power (onshore and offshore), hydro power, geothermal energy and solar power provided in this study to illustrate a potential pathway.

In this document, we refer to `metric tons`

front cover image: Wind turbines creating clean energy in Fukushima Japan © STUDIOCASPAR/ISTOCK **image:**Rice fields in Kamikatsu, Tokushima,Japan

Introduction

Turning a nuclear crisis into an opportunity

The tragic March 11, 2011 earthquake, tsunami and nuclear disaster will be a day remembered in history. Not only because after Chernobyl we were told that a nuclear crisis of this scale could never happen again, but also because the economic, social, and environmental catastrophe created by the triple meltdown at the Fukushima Daiichi has created a turning point in global energy policy.

The Fukushima Daiichi crisis triggered intensive discussions on the safety of nuclear power, and as a first result, Germany, Switzerland, and Italy chose to end their nuclear programmes and to phase out existing reactors. In Japan, public opinion now overwhelmingly favours renewable energy over nuclear, and while 74% of the installed nuclear capacity has been shut down for safety reasons since between March and August (remaining capacity is 12,600MW), a country-wide effort to reduce energy has proven that Japan can survive without them.

Only a dynamic shift in how we generate and use energy will make it possible to Japan's reliance on fundamentally dangerous nuclear technology, minimise the risk of climate change, and create a thriving green economy.

To achieve this, Greenpeace is presenting three scenarios: usual path, an Energy [R]evolution scenario detailing a nuclear phase-out and switch to renewables, and an Advanced Energy [R]evolution scenario created in the aftermath of the nuclear crisis showing how Japan can make a rapid switch to a safe, renewable future while closing all reactors permanently in 2012.

If Japan takes the Advanced Energy [R]evolution pathway it is possible to:

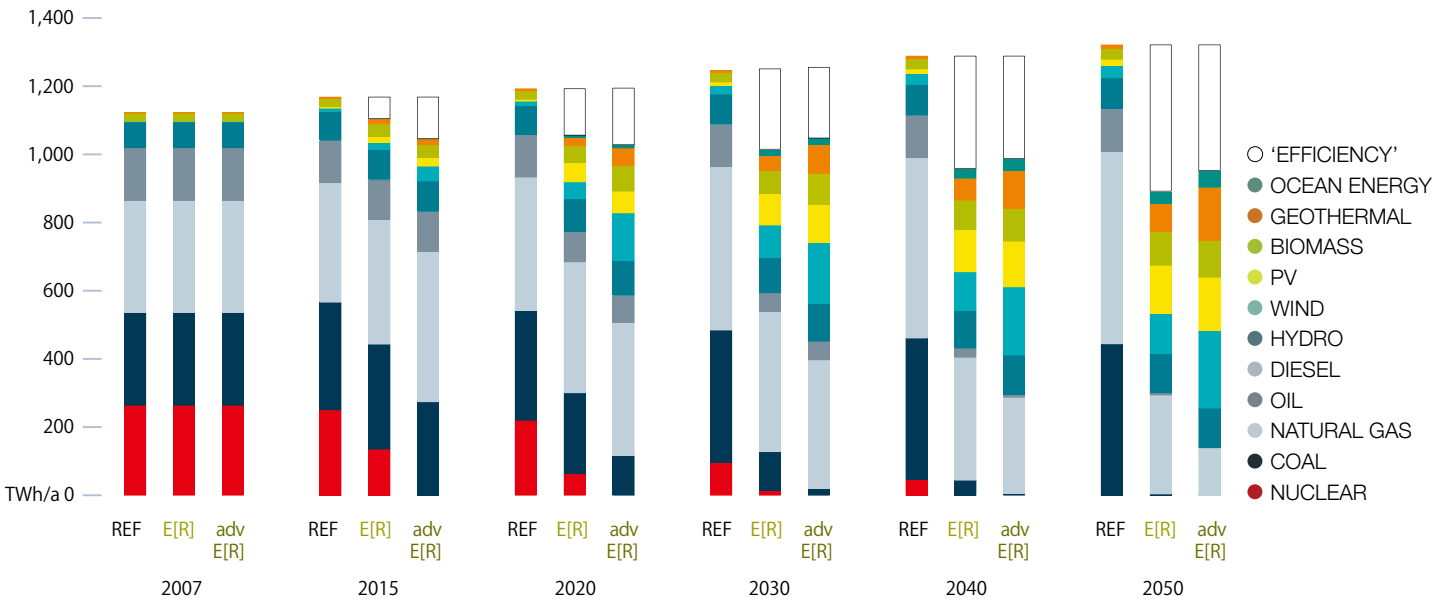
- Phase out nuclear power generation by 2012
- Generate 43% of electricity from renewable energy by 2020
- Reduce 25% of greenhouse gas emissions by 2020 (in comparison of 1990)

* In the Advanced Energy [R]evolution scenario, Japan can completely phase out nuclear power in 2012 and still reach its pledge of reducing Greenhouse gas emission by 25% below 1990 levels by 2020 with 24% reductions coming through domestic means, and the remaining sourced through flexible mechanisms internationally.

For a full report visit;
www.greenpeace.org/japan/Global/japan/pdf/er_report.pdf

Figure S-1: 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]



Energy Efficiency

Figure S-2: A decentralised energy future

1. PHOTOVOLTAIC, SOLAR FACADES WILL BE A DECORATIVE ELEMENT ON OFFICE AND APARTMENT BUILDINGS. PHOTOVOLTAIC SYSTEMS WILL BECOME MORE COMPETITIVE AND IMPROVED DESIGN WILL ENABLE ARCHITECTS TO USE THEM MORE WIDELY.
2. RENOVATION CAN CUT ENERGY CONSUMPTION OF OLD BUILDINGS BY AS MUCH AS 80% - WITH IMPROVED HEAT INSULATION, INSULATED WINDOWS AND MODERN VENTILATION SYSTEMS.
3. SOLAR THERMAL COLLECTORS PRODUCE HOT WATER FOR BOTH THEIR OWN AND NEIGHBOURING BUILDINGS.
4. EFFICIENT THERMAL POWER (CHP) STATIONS WILL COME IN A VARIETY OF SIZES - FITTING THE CELLAR OF A DETACHED HOUSE OR SUPPLYING WHOLE BUILDING COMPLEXES OR APARTMENT BLOCKS WITH POWER AND WARMTH WITHOUT LOSSES IN TRANSMISSION.
5. CLEAN ELECTRICITY FOR THE CITIES WILL ALSO COME FROM FARTHER AFIELD. OFFSHORE WIND PARKS AND MEGA SOLAR POWER STATIONS HAVE ENORMOUS POTENTIAL.

As of August 2011, only 12 of Japan's 54 nuclear reactors were online, and by May 2012, all reactors in Japan will be shut down for safety check-ups. To date this has not had a significant effect as Japan has extensive experience in energy efficiency, however, there is still enormous potential for it to do more. Energy efficiency offers some of the simplest, easiest and quickest measures for reducing energy demands, greenhouse gas emissions and cost to end-users.

Along with efficiency, Japan can win the no-nuclear challenge by ramping up renewable generation capacity to take advantage of its abundant solar, wind, geothermal and other renewable energy resources. With its top class technology and business acumen, significant renewable capacity can be installed not only rapidly, but also where it is needed most.

The Advanced Energy [R]evolution emergency plan for a complete nuclear shut down in 2012 follows a three step approach, including stricter efficiency measures, increasing renewable energy capacity - especially wind and solar – and a preliminary increase of the capacity factors of gas power plants between 2012 and 2020. The details of this plan are:

1. Energy Efficiency

Most short term efficiency measures implemented between March and September 2011 need to remain in place. Additionally:

- The annual total electricity must be reduced by 1.7% per year between 2011 and 2020

- Strict efficiency and load management concepts must be immediately implemented to avoid shortages during peak demand hours as well as total annual demands for all sectors

- Strict mandatory efficiency standards are required

The Advanced Energy [R]evolution scenario takes the Institute for Sustainable Energy Policies' (ISEP) efficiency concept into account, and the load reduction strategy will lead to a reduction of up to 11 GW if:

- Ampere-capacities to households with demands less than 50kW are cut 20%. This will drive a decrease demand of 2.5GW

- A special price for peak-demand periods is introduced for users with demands of 50kW-500kW. This will decrease demand by approximately 2GW

- A price for peak-demand periods is introduced along with a gradual application of supply-demand contracts for users with demands of 500kW-2,000kW. This will decrease demand by approximately 1.5GW

- The application (led by the government in principle) of supply-demand contracts is required for users with demands of more than 2,000kW. This will decrease demand by approximately 5GW

Electricity Generation: 2012-2020

2. Power Generation

Faster uptake of renewables (especially solar photovoltaic and wind power due to their short construction times) and increased capacity factors for existing gas power plants are at the core of the emergency concept.

• Gas: increase average capacity factor of all gas power plants and use them as base load power plants over the coming years. By 2020 the average capacity factor will be back on "standard levels"

• Backup power: Gas power plants will be used to cover dips in flexible generation, and no additional capacity will be needed as current gas power generation capacity is more than enough to cover the entire time period 2012 – 2020

• Wind: increase average annual market from 220 MW in 2010 to 5,000 MW/a between 2012 and 2015 and around 6,000 MW/a between 2016 and 2020

• Photovoltaic: increase average annual market from 990 MW in 2010 up to 5,000 MW/a between 2012 and 2015 and around 6,700 MW/a between 2016 and 2020

In order to implement the needed additional renewable energy capacity, Greenpeace recommends guaranteed access to the grid, as well as a streamlined licensing process be included in feed-in law legislation, and a workable fixed price per kilowatt-hour over 20 years be implemented. This will accelerate the renewable power market in Japan.

Possible environmental impacts by the projects should be carefully assessed and appropriate measures should be taken accordingly.

3. Infrastructure

In order to integrate flexible solar and wind power capacities into the existing grid while transporting more capacity from gas power plants to the load centres of Japan, grid enforcements may be required. Support programs for the expansion of "Smart-Grids" will lead to faster implementation of energy efficiency as well as the more efficient use of renewable electricity.

Equal to the suggested renewable power plant licensing process, clear policy frameworks are needed to enable grid operators to implement needed grid enforcement as fast as possible.

Table S-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	57.6
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 CO2 emissions	million T CO_2/a	1,267	1,261	1,254	1,247	1,171	1,095	1,018	942	866
CO2 emissions compared to 1990 levels	%	111%	110%	110%	109%	102%	96%	89%	82%	76%

Electricity Generation: 2012-2020

Figure S-3 shows the emergency plan for an immediate nuclear phase out compared to a "gradual phase out" of nuclear power by 2030.

As opposed to figure S-1 on page 3, the power generation calculations shown in figure S-3 only represent the amount of wind, solar and gas electricity needed to replace nuclear electricity towards a complete phase-out.

image A worker enters a turbine tower for maintenance.

Figure S-3: Japan - emergency plan: nuclear generation replacement strategy

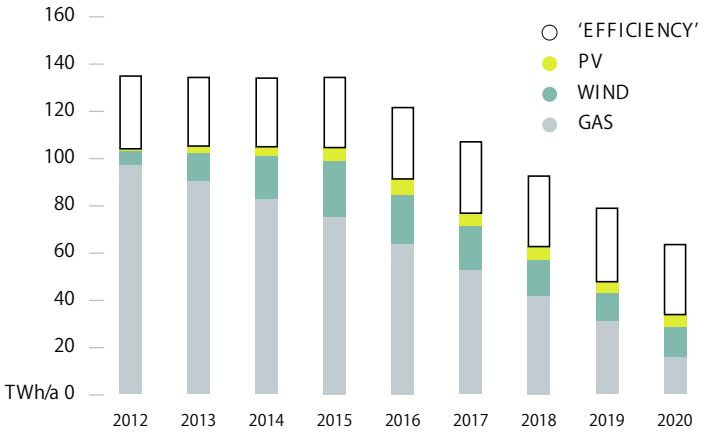


Table S-2: summary: power generation and installed capacity development between 2012 and 2020

INSTALLED CAPACITY IN GW - EXCLUDING CHP	2007	2012	2013	2014	2015	2016	2017	2018	2019	2020
Coal	49.6	48.1	47.3	46.5	45.7	40.4	35.2	29.9	24.6	19.3
Gas	54.7	58.0	59.7	61.3	63.0	62.2	61.5	60.8	60.1	59.4
Oil	46.4	46.2	46.0	45.9	45.8	44.4	43.1	41.7	40.4	39.0
Diesel	3.2	2.9	2.8	2.6	2.5	2.4	2.3	2.2	2.1	2.0
Nuclear	48.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biomass	3.1	3.7	4.1	4.4	4.7	4.8	4.9	5.0	5.1	5.2
Hydro	19.0	20.0	20.5	21.0	21.5	22.1	22.7	23.3	23.9	24.5
Wind	1.5	8.3	13.3	18.3	23.3	29.4	35.6	41.7	47.9	56.0
Photovoltaics	1.7	8.9	13.9	18.9	23.9	30.6	37.3	44.1	50.8	57.0
Geothermal	0.6	1.4	1.9	2.3	2.8	3.6	4.4	5.3	6.1	6.9
Ocean Energy	0.0	0.1	0.2	0.2	0.3	0.7	1.2	1.7	2.1	2.6
ELECTRICITY GENERATION [TWH] - EXCLUDING CHP										
Coal	272	273	274	274	274	243	211	179	148	116
Gas	328	439	438	436	434	422	411	400	389	374
Oil	153	152	152	152	115	107	99	92	85	78
Diesel	3	3	3	3	3	2	2	2	2	2
Nuclear	264	0	0	0	0	0	0	0	0	0
Biomass	23	28	30	33	35	36	36	37	37	38
Hydro	74	79	82	85	88	91	93	96	98	101
Wind	3	15	24	34	44	59	76	94	114	140
Photovoltaics	2	10	15	20	26	34	41	49	56	64
Geothermal	3	8	11	14	17	23	29	35	42	49
Ocean Energy	0	0	1	1	1	3	4	6	7	9
Final electricity consumption Advanced E[R]	1,010	960	950	941	931	928	925	923	920	917

Economic [R]ecovery

Following the implementation of the emergency plan between now and 2020, the Advanced Energy [R]evolution scenario will continue to make huge contributions to Japan's economy, employment sector, energy independence and greenhouse gas emission reduction targets by:

1. Continuing to drive the country towards its energy efficiency potential by ensuring that primary energy demand decreases from the current 21,767 PJ/a (2007) to 11,114 PJ/a in 2050.

2. Encouraging increasing use of electric drives in the transport sector, and ensuring that hydrogen produced by electrolysis from excess renewable electricity plays a much bigger role. After 2020, the final energy share of electric vehicles on the road will increase to 11% by 2020, and 49% by 2050.

3. Enabling the increased use of combined heat and power generation (CHP) to improve the supply system's energy conversion efficiency, increasingly using natural gas and biomass.

4. Encouraging pioneering use of renewable energy. By 2020, 43% of electricity will be produced from renewable sources, increasing to 85% by 2050. A capacity of 277 GW will produce 813 TWh/a of renewable electricity in 2050.

5. Enabling the contribution of renewables in the heat supply sector to increase to 22% by 2020 and 71% by 2050. Fossil fuels will be increasingly replaced by more efficient modern technologies, in particular biomass, solar collectors and geothermal.

6. Exploiting existing large efficiency potentials in the transport sector by a modal shift from road to rail, and by using much lighter and smaller vehicles.

7. Ensuring that by 2050, 64% of primary energy demand will be covered by renewable energy sources.

Economic [R]evolution

Renewable energy will initially cost more to implement than existing fossil fuels. The slightly higher electricity generation costs under the Advanced Energy [R]evolution scenario will be compensated for, however, by reduced demand for fuels in other sectors such as heating and transport. Assuming average costs of 3 cents/kWh for implementing energy efficiency measures, the additional cost for electricity supply under the Advanced Energy [R]evolution scenario will amount to a maximum of $100 million/a in 2015. These additional costs, which represent society's investment in an environmentally benign, safe and economic energy supply, continue to decrease after 2015.

Future Fuel Cost

It is assumed that average crude oil prices will increase from around $80 per barrel in 2009 to $130 per barrel in 2020, and continue to rise to $150 per barrel in 2050. Natural gas import prices are expected to increase by a factor of four between 2008 and 2050, while coal prices will nearly double, reaching $360 per tonne in 2050. A CO2 'price adder' is applied, which rises from $20 per tonne of CO2 in 2020 to $50 per tonne in 2050.

Figure S-5 : Japan - development of total electricity supply costs & development of specific electricity generation costs under three scenarios

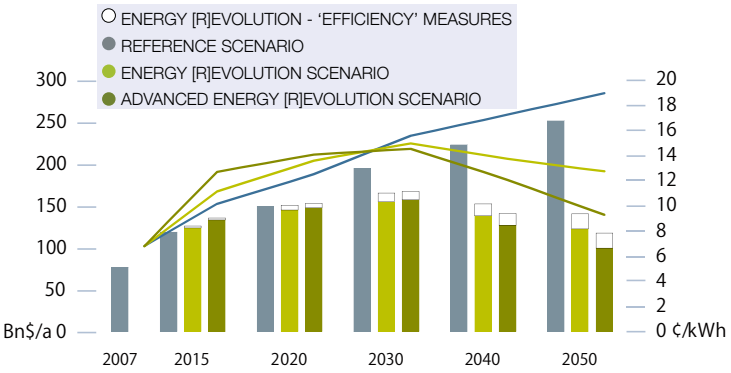
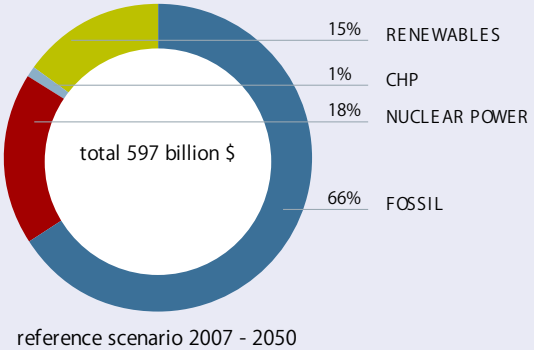
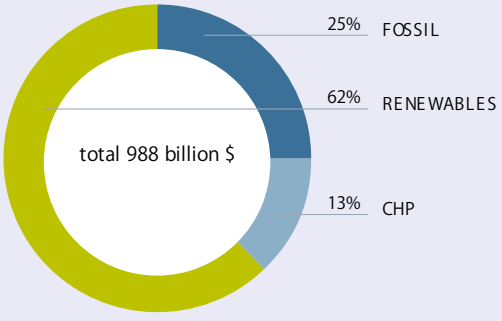


Figure S-4: Japan - investment shares - Reference versus Advanced Energy [R]evolution scenario



reference scenario 2007 - 2050



advanced energy [r]evolution scenario 2007 - 2050

Employment, Policy and Emissions

Employment

Energy sector jobs are set to increase significantly by 2015 under the Advanced Energy [R]evolution scenario, with only a slight increase in the Reference scenario. In 2010, there are 81,500 electricity sector jobs in Japan.

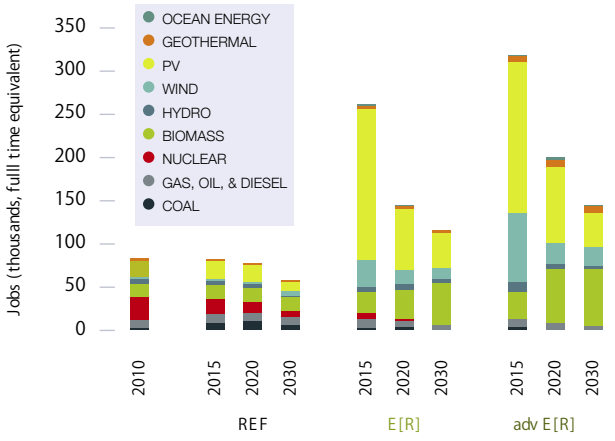
• In the Reference scenario, jobs stay constant to 2015, and then fall by 5% by 2020 (a loss of 4,800 jobs relative to 2010), and then decrease further to 57,000 jobs by 2030

• In the Advanced scenario, jobs almost quadruple to 326,000 jobs in 2015 (244,000 additional jobs), then drop back to 198,000 jobs in 2020, and 144,000 jobs in 2030, a 76% increase from 2010

• Solar PV shows particularly strong growth, reaching a peak of more than 170,000 jobs in 2015 in both the [R]evolution scenarios

These calculations do not include the jobs associated with decommissioning nuclear power stations, which would be significant in all scenarios. Rapidly moving towards a renewable energy future in Japan will drive enormous job growth and economic recovery as a huge new green industry is formed.

Figure S-6: jobs by technology under three scenarios



Policy changes

To make the Energy [R]evolution real, Greenpeace demands that the following policies and actions are implemented in the energy sector:

1. Phase out all subsidies for fossil fuels and nuclear energy.

2. Internalise the external (social and environmental) costs of energy production through 'cap and trade' emissions trading.

3. Mandate strict efficiency standards for all energy consuming appliances, buildings and vehicles.

4. Establish legally binding targets for renewable energy and combined heat and power generation.

5. Reform the electricity markets by guaranteeing priority access to the grid for renewable power generators, and by separating electricity utilities from the grid.

6. Provide defined and stable returns for investors, for example by feed-in tariff programmes.

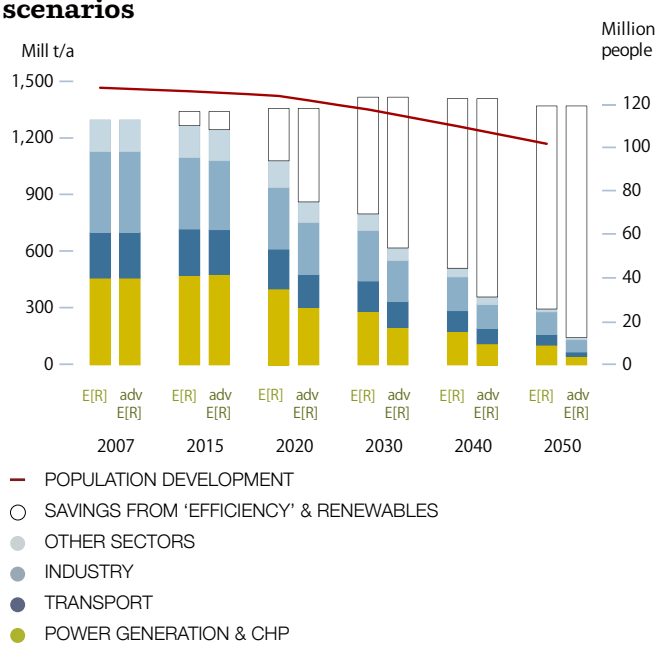
7. Implement better labelling and disclosure mechanisms to provide more environmental product information.

8. Increase research and development budgets for renewable energy and energy efficiency.

Development of CO2 emissions

In the Advanced Energy [R]evolution scenario, Japan can completely phase out nuclear power in 2012 and still reach its pledge of reducing greenhouse gas emission by 25% below 1990 levels by 2020 with 24% reductions coming through domestic means, and the remaining sourced through flexible mechanisms internationally.

Figure S-7: japan - development of CO2 emissions by sector under both Energy [R]evolution scenarios



Energy Shift Now

Energy Shift Now

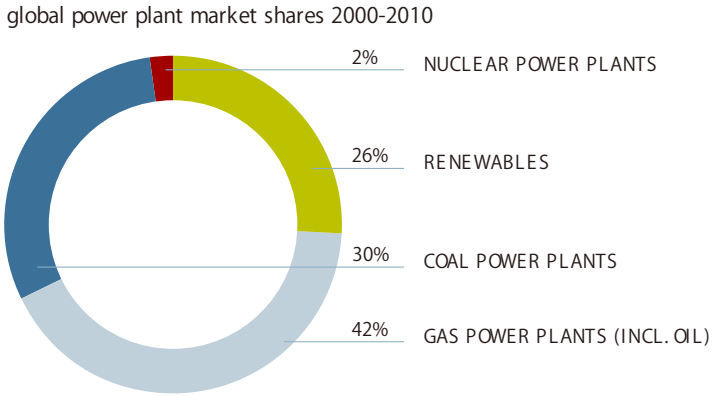
Japan's response to the Fukushima nuclear disaster and the threat of climate change demands nothing short of an Energy [R]evolution.

The Advanced Energy [R]evolution scenario provides a robust short-term emergency plan to ensure Japan has enough generation capacity to listen to the demands of its people and switch off its nuclear reactors permanently in 2012. It also provides a long-term roadmap that will boost jobs, economic growth and energy independence, ensures that Japan will never again be at risk of a catastrophic nuclear disaster, and provides its people with a clean and sustainable future.

The global renewable energy market

The bright future for renewable energy is already underway. The global market for renewable energy is booming internationally. Between 2005 and 2010, installed capacity of wind power grew by 255% globally, while solar photovoltaic grew by over 1000%. Between 2000 and 2010, 26% of all new power plants worldwide were renewables – mainly wind. Nuclear remains irrelevant on a global scale with just 2% of the global market share.

Figure S-8: power plant market shares



*If China is excluded, the share for coal power plants drops from 30% to 10% in the same period.

Huge renewable energy potential

According to the Research Association for Solar Power, the energy in the sunshine that reaches the earth can satisfy current global demand 2,850 times over. Only a small percentage of that potential is technically accessible, however, even this fraction is enough to provide almost six times more power than the world currently consumes.

image The "Energy Shift Parade" through Shibuya on the three-month anniversary of the East Japan earthquake disaster and the start of the Fukushima Daiichi nuclear crisis.

Figure S-9: renewable power capacities, developing countries, EU and top six countries, 2010 (not including hydropower)

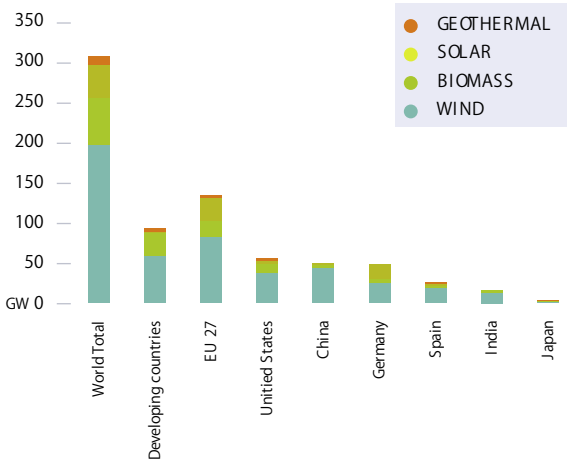
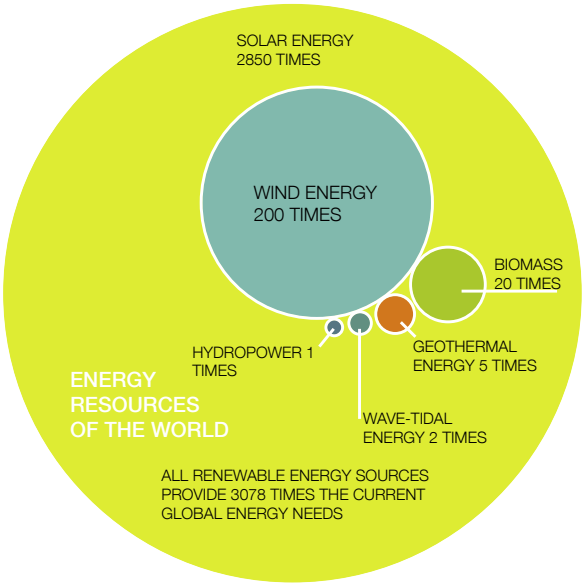


Figure S-10: energy resources of the world



[r]evolution

A SUSTAINABLE ENERGY OUTLOOK FOR JAPAN

Japan: Advanced Energy [R]evolution scenario

Japan: electricity generation

TWh/a	2007	2015	2020	2030	2040	2050
Power plants	1,123	1,036	970	962	883	819
Coal	272	274	116	19	5	0
Lignite	0	0	0	0	0	0
Gas	328	434	374	350	251	108
Oil	153	115	78	54	9	0
Diesel	3	3	2	2	1	1
Nuclear	264	0	0	0	0	0
Biomass	23	35	38	39	39	39
Hydro	74	88	101	110	114	115
Wind	3	44	140	179	200	228
PV	0	26	64	111	135	156
Geothermal	3	17	49	80	93	120
Solar thermal power plants	0	0	0	0	0	1
Ocean energy	0	1	9	19	35	50
Combined heat & power production	0	10	58	87	107	138
Coal	0	0	0	0	0	0
Lignite	0	0	0	0	0	0
Gas	0	8	18	28	31	31
Oil	0	0	0	0	0	0
Biomass	0	2	38	52	56	69
Geothermal	0	0	2	6	18	35
Hydrogen	0	0	0	1	2	4
CHP by producer						
Main activity producers	0	2	26	34	44	65
Autoproducers	0	8	32	53	63	73
Total generation	1,123	1,046	1,028	1,049	990	957
Fossil	757	834	587	452	297	140
Coal	272	274	116	19	5	0
Lignite	0	0	0	0	0	0
Gas	328	442	391	378	282	139
Oil	153	115	78	54	9	0
Diesel	3	3	2	2	1	1
Nuclear	264	0	0	0	0	0
Hydrogen	0	0	0	1	2	4
Renewables	103	213	440	596	690	813
Hydro	74	88	101	110	114	115
Wind	3	44	140	179	200	228
PV	0	26	64	111	135	156
Biomass	23	37	76	91	95	108
Geothermal	3	17	51	86	111	155
Solar thermal	0	0	0	0	0	1
Ocean energy	0	1	9	19	35	50
Distribution losses	51	0	0	47	46	43
Own consumption electricity	62	0	0	52	28	16
Electricity for hydrogen production	0	0	0	0	6	17
Final energy consumption (electricity)	1,010	931	917	950	909	880
Fluctuating RES (PV, Wind, Ocean)	3	71	213	309	370	434
Share of fluctuating RES	0.2%	6.7%	20.7%	29.4%	37.4%	45.4%
RES share	9.1%	20.3%	42.8%	56.8%	69.8%	85.0%
'Efficiency' savings (compared to Ref.)	0	126	210	282	401	513

Japan: heat supply

PJ/a	2007	2015	2020	2030	2040	2050
District heating plants	25	42	124	163	166	134
Fossil fuels	19	29	68	68	42	20
Biomass	7	12	49	72	71	59
Solar collectors	0	0	1	1	7	9
Geothermal	0	0	6	21	46	46
Heat from CHP	0	39	249	359	479	616
Fossil fuels	0	26	62	97	104	89
Biomass	0	13	165	203	209	233
Geothermal	0	1	21	56	159	283
Fuel cell (hydrogen)	0	0	1	4	7	11
Direct heating[1]	4,678	4,683	4,153	3,612	2,905	2,188
Fossil fuels	4,555	4,376	3,380	2,482	1,640	730
Biomass	92	132	234	255	245	216
Solar collectors	23	99	231	383	415	489
Geothermal[2]	9	75	307	491	591	669
Hydrogen	0	0	0	0	14	83
Total heat supply[1]	4,703	4,764	4,526	4,133	3,550	2,937
Fossil fuels	4,573	4,431	3,510	2,647	1,786	839
Biomass	99	158	448	530	525	508
Solar collectors	23	99	232	385	421	499
Geothermal[2]	9	76	334	568	796	998
Fuel cell (hydrogen)	0	0	1	4	21	94
RES share (including RES electricity)	2.8%	7.0%	22.4%	35.9%	49.5%	70.9%
'Efficiency' savings (compared to Ref.)	0	382	754	1,179	1,752	2,291

1) including cooling. 2) including heat pumps

Japan: co_2 emissions

MILL t/a	2007	2015	2020	2030	2040	2050
Condensation power plants	460	479	301	194	107	42
Coal	220	221	93	16	4	0
Lignite	0	0	0	0	0	0
Gas	143	185	158	144	97	41
Oil	96	72	49	33	6	0
Diesel	2	1	1	1	1	0
Combined heat & power production	0	4	9	13	14	12
Coal	0	0	0	0	0	0
Lignite	0	0	0	0	0	0
Gas	0	4	9	13	14	12
Oil	0	0	0	0	0	0
CO_2 emissions power generation (incl. CHP public)	460	483	309	207	121	54
Coal	220	221	93	16	4	0
Lignite	0	0	0	0	0	0
Gas	143	189	166	157	111	53
Oil & diesel	98	73	50	34	6	1
CO_2 emissions by sector	1,301	1,247	866	620	361	147
% of 1990 emissions	114%	109%	76%	54%	32%	13%
Industry	210	195	158	129	94	51
Other sectors	170	165	111	66	37	13
Transport	244	237	176	137	83	23
Power generation (incl. CHP public)	460	480	304	199	113	46
Other conversion	217	170	117	89	34	15
Population (Mill.)	127.4	126	124	117	110	102
CO_2 emissions per capita (t/capita)	10.2	9.9	7.0	5.3	3.3	1.4

Japan: installed capacity

GW	2007	2015	2020	2030	2040	2050
Power plants	226	233	272	310	315	315
Coal	50	46	19	3.2	1.0	0
Lignite	0	0	0	0	0	0
Gas	55	63	59	62	60	54
Oil	46	46	39	36	18	0.4
Diesel	3.2	2.5	2.0	1.5	1.0	0.8
Nuclear	48	0	0.0	0	0	0
Biomass	3.1	4.7	5.2	5.4	5.6	6.3
Hydro	19	21	24	26	27	27
Wind	1.5	23	56	64	68	71
PV	0.01	24	57	96	112	125
Geothermal	0.6	2.8	6.9	11	13	16
Solar thermal power plants	0	0	0	0	0	0
Ocean energy	0	0.3	2.6	5.4	10	14
Combined heat & power production	0	1.8	12	16	20	28
Coal	0	0	0	0	0	0
Lignite	0	0	0	0	0	0
Gas	0	1.4	3.4	6.1	7.1	10
Oil	0	0	0	0	0	0
Biomass	0	0.4	8.1	8.8	9.4	12
Geothermal	0	0	0.4	1.1	3.0	5.6
Hydrogen	0	0	0	0.2	0.4	0.7
CHP by producer						
Main activity producers	0	0.5	6.7	7.3	8.8	13
Autoproducers	0	1.4	5.3	9.0	11	15
Total generation	226	235	284	327	335	343
Fossil	154	158	123	108	87	65
Coal	50	46	19	3.2	1.0	0
Lignite	0	0	0	0	0	0
Gas	55	64	63	68	67	64
Oil	46	46	39	36	18	0.4
Diesel	3.2	2.5	2.0	1.5	1.0	0.8
Nuclear	48	0	0.0	0	0	0
Hydrogen	0	0	0	0.2	0.4	0.7
Renewables	24	76	161	218	248	277
Hydro	19	21	24	26	27	27
Wind	1.5	23	56	64	68	71
PV	0.01	24	57	96	112	125
Biomass	3.1	5.2	13	14	15	18
Geothermal	0.6	2.8	7.4	12	16	22
Solar thermal	0	0	0	0	0.1	0.3
Ocean energy	0	0.3	2.6	5.4	10	14
Fluctuating RES (PV, Wind, Ocean)	1.5	47	116	165	190	210
Share of fluctuating RES	0.7%	20.0%	40.7%	50.6%	56.7%	61.4%
RES share	10.7%	32.5%	56.6%	66.7%	74.0%	80.8%

Japan: primary energy demand

PJ/a	2007	2015	2020	2030	2040	2050
Total	21,767	19,484	17,534	15,774	13,264	11,114
Fossil	18,162	17,650	13,280	10,333	7,112	4,015
Hard coal	4,782	3,391	1,505	336	109	27
Lignite	0	0	0	0	0	0
Natural gas	3,680	5,251	4,979	4,653	3,311	1,732
Crude oil	9,699	9,008	6,796	5,343	3,692	2,256
Nuclear	2,879	0	0	0	0	0
Renewables	726	1,834	4,254	5,441	6,152	7,098
Hydro	266	317	364	396	410	414
Wind	9	157	504	644	720	821
Solar	23	196	470	786	927	1,083
Biomass	310	663	1,479	1,604	1,611	1,628
Geothermal	118	499	1,404	1,942	2,358	2,972
Ocean Energy	0	4	32	68	126	180
RES share	3.3%	9.4%	24.3%	34.5%	46.4%	63.9%
'Efficiency' savings (compared to Ref.)	0	3,149	5,242	6,793	8,873	10,248

Japan: final energy demand

PJ/a	2007	2015	2020	2030	2040	2050
Total (incl. non-energy use)	14,311	14,086	12,950	11,941	10,308	8,597
Total (energy use)	12,541	12,316	11,181	10,171	8,538	6,828
Transport	3,450	3,514	3,020	2,693	2,086	1,391
Oil products	3,382	3,292	2,410	1,853	1,103	267
Natural gas	0	6	39	62	66	65
Biofuels	0	124	314	327	336	346
Electricity	68	91	258	435	550	676
RES electricity	6	19	110	247	384	575
Hydrogen	0	0	0	16	32	37
RES share Transport	0.2%	4.1%	14.0%	21.7%	35.5%	68.5%
Industry	4,154	4,028	3,743	3,563	3,198	2,847
Electricity	1,219	1,166	1,031	1,015	923	875
RES electricity	111	237	442	576	644	744
District heat	1	31	134	222	264	341
RES district heat	0	8	86	145	207	295
Coal	788	587	315	123	45	10
Oil products	1,239	1,153	973	824	585	208
Gas	793	915	942	905	736	522
Solar	0	27	93	152	193	273
Biomass and waste	114	122	156	157	161	150
Geothermal	0	29	98	165	276	381
Hydrogen	0	0	0	0	14	87
RES share Industry	5.4%	10.5%	23.4%	33.6%	46.6%	67.3%
Other Sectors	4,937	4,774	4,418	3,915	3,254	2,589
Electricity	2,350	2,093	2,007	1,936	1,734	1,477
RES electricity	215	425	860	1,100	1,210	1,255
District heat	24	48	237	330	353	397
RES district heat	6	14	141	199	271	352
Coal	25	7	0	0	0	0
Oil products	1,450	1,384	714	305	120	26
Gas	1,055	1,086	999	735	440	137
Solar	23	75	148	231	240	234
Biomass and waste	1	45	144	150	130	103
Geothermal	9	35	168	228	238	215
RES share Other Sectors	5.1%	12.5%	33.1%	48.7%	64.2%	83.4%
Total RES	486	1,160	2,761	3,687	4,321	5,030
RES share	3.9%	9.4%	24.7%	36.2%	50.6%	73.7%
Non energy use	1,770	1,770	1,770	1,770	1,770	1,770
Oil	1,737	1,737	1,737	1,737	1,737	1,737
Gas	16	16	16	16	16	16
Coal	16	16	16	16	16	16