Energy Scenario Proposal for Decarbonizing Japan

Part I: Energy Efficiency

Executive Summary

WWF Japan

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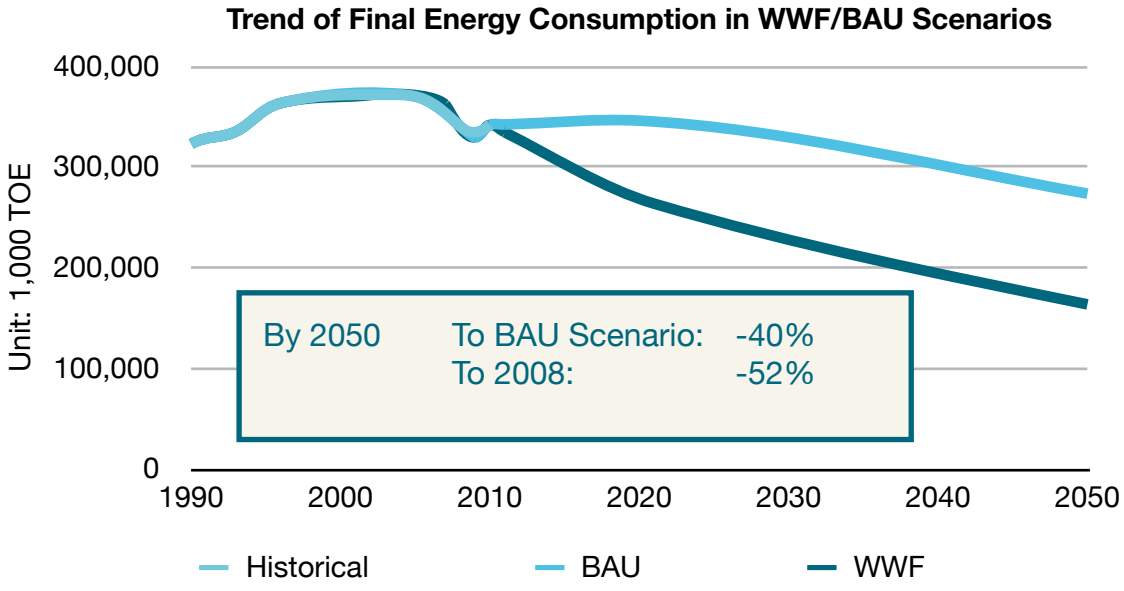
Introduction

This is an Executive Summary for WWF Japan's *Energy Scenario Proposal for Decarbonizing Japan: Part I Energy Efficiency*. The Energy Scenario Proposal has four parts and this is the first part. The purpose of the whole Energy Scenario Proposal is to look at Japan's possibility to achieve 100% renewable future. This Part I examines the potential for **energy efficiency** in Japan as a first step.

The result is impressive. WWF Scenario in this report shows that **Japan can halve its final energy consumption by 2050 compared to the current level.** In other words, the level of energy consumption is approximately 40% lower than the level where no strong energy efficiency measures are assumed. Such massive energy efficiency improvement and the resultant reduction of energy consumption can be done through technologies and measures that we can already assume today and it does not require people to live in a life of austerity.

Figure 1. WWF Scenario and BAU Scenario



Source: WWF Japan.

1. Assumptions and Methodology

In the report, the following four steps were taken to examine the energy efficiency potential in Japan.

1. Energy efficiency technologies and measures are selected and assessed for each sector (i.e. industry, commercial, household and transport sectors) and how much energy efficiency rate can be improved in those sectors.
2. Contribution of the technologies and measures are quantified by the following formula:
3. Add up the energy consumption of all the sectors to produce the total final energy consumption of Japan in 2050

Final energy consumption of a sector in 2020/2030/2040/2050
= Final energy consumption of the sector in 2008
* Rate of change in activity level of the sector
* Rate of energy efficiency improvement

"Reference Case" in *Asia/World Energy Outlook 2010* by the Institute of Energy Economics, Japan (IEEJ) is used as Business As Usual (BAU) Scenario in this report. The same activity level assumptions (e.g. GDP growth rate, population, production of heavy industries, etc) are taken out from the IEEJ's reference case scenario and are used in the WWF Scenario.

As can be seen in Table 1-1, in the BAU scenario, Japan's population is projected to decrease by 25% between 2008 and 2050, while real GDP is predicted to increase by 1.56 times, from 544 trillion JPY to 851 trillion JPY. Over this period, although GDP is growing, energy consumption is in fact decreasing due to the decreasing population. Even in the BAU scenario, final energy consumption falls by 19.4% from 2008 to 2050.

Table 1. Activity level assumptions in the *Asia/World Energy Outlook 2010* - Reference Case

Items	2008	2020	2035	2050
Population (millions)	127	122	110	95
No. of households (millions)	52	54	51	45
Real GDP (trillion JPY, from 2000 prices)	544	657	767	851
Manufacturing production (2000=100)	95	124	142	156
Crude steel (millions of tonnes)	105	114	101	88
Ethylene (millions of tonnes)	6	7	6	5
Cement (millions of tonnes)	66	55	51	41
Paper/Cardboard (millions of tonnes)	28	30	30	28

Source: Energy Data and Modeling Center (EDMC) (2010) *Handbook of Energy & Economic Statistics in Japan*. Energy Conservation Center Japan.

2. Overall results of energy-saving technologies and measures

Following the Great East Japan Earthquake and the Fukushima Daiichi Power Plant incident in March 2011 and the subsequent electricity-saving demands made by the government, awareness of energy-saving methods and technologies increased greatly. LED light-bulbs became widely used, lighting of walkways was reduced, companies operated reduced hours and electric fans were used rather than air-conditioning even during hot summer. Some of these measures are only possible in case of emergency like the aftermath of the great earthquake but others can greatly contribute to energy savings if the practices are sustained.

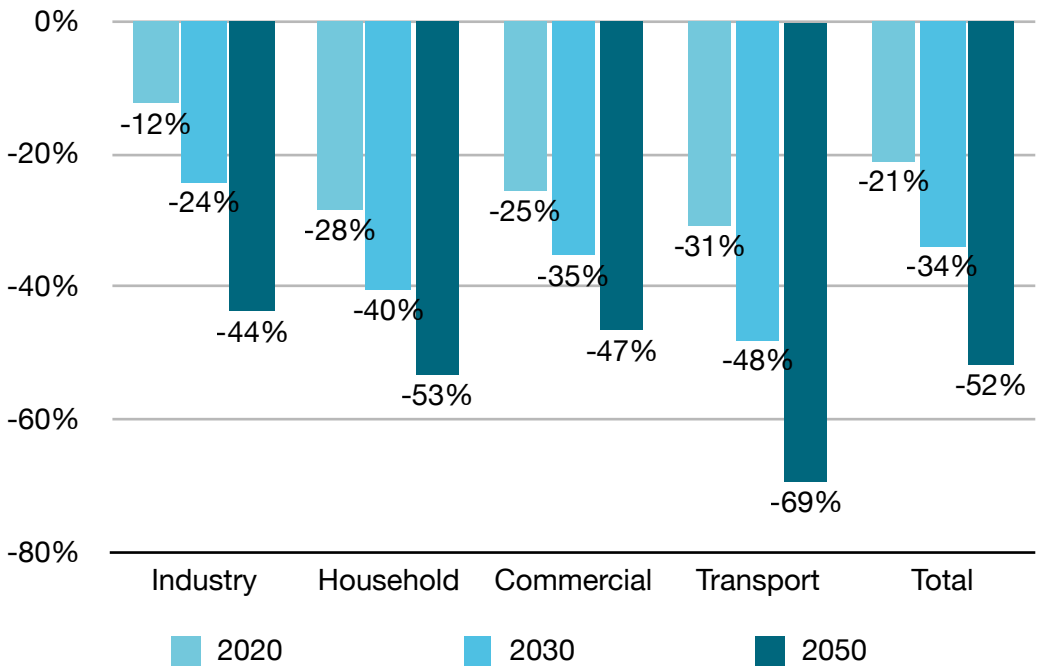
In this report, we examine energy efficiency potential of selected technologies and measures in each of sectors (e.g. industry, household, commercial and transport sectors) and sub-sectors (e.g. lighting in household). The results of assessment are summarized in Table 2 and Figure 2.

Table 2. Technologies and measures assessed in WWF Scenario

Sector	Technologies and measures	Reduction rate of energy consumption compared to the 2008 levels in 2050
Household	More improved LED replacing conventional lighting / the current "next generation" insulation standard becoming the average / More heat pumps and the average efficiency getting doubled / More highly efficient heat water supply systems (efficiency doubled) / Improved efficiency of home appliances but it gets offset by wider use of them / Home Energy Management Systems and Smart Meter / Share of stand-by electricity consumption 1% in household	2050: -74%
Commercial (Building)	The current "next generation" insulation standard becoming the average / More heat pumps and the average efficiency getting doubled / Air-conditioning systems' efficiency doubled / Greening of the cities / Cool Biz and Warm Biz / More LED, task-lighting, use of natural lighting, etc / Building Energy Management Systems / Improved efficiency of electronic appliances	2050: -47%
Industry	Wider use of inverters to achieve efficient motors / Recycling rate in steel production becoming 70% / 30% improvements in other major manufacturing industries	2050: -41%
Transport	Car sharing / "Eco-drive" / shifting to lighter vehicles by using Fiber Reinforced Plastics, etc / improved fuel economies / modal shifts / "eco-ship" using fuel cells	2050: -69%
Total		2050: -51%

Source: WWF Japan.

Figure 2. Reduction rate of energy consumption by sector



Source: WWF Japan.

3. Description of sector-specific assumptions

3.1 Household sector

For household sector, improvements of lighting efficiency, residential insulation, boilers, heating and cooling, etc are assumed.

For example, in the WWF Scenario, incandescent light-bulbs will be entirely replaced by fluorescent lights and light-emitting-diodes (LED) by 2050. The brightness of a 1W LED light-bulb is currently around 80 lumens but it is assumed that the brightness will likely be up to 200 lm/W before 2020 (compared to 96~110 lm/W fluorescent bulbs), and their price continues to fall rapidly. This brings down the energy consumption for "lighting" subsector in household to one forth of the current (2008) level of energy consumption.

Similarly, improvements in insulation of residential buildings are assumed. High energy-saving standards introduced in 1999, can reduce heating demand to 24% for detached houses and 12% for apartments compared to non-insulated homes. However, of 53,200,000 homes surveyed in 2005, 38% were non-insulated, 59% were insulated to lesser standards, and only 3% were insulted to these high standards of insulation. The WWF Scenario project that all homes will have transitioned to these highest standards by 2050, which, taking into consideration expected changes in numbers of residences, will reduce total heating demand to 36% of 2010 levels.

Similar assessments are done for contributions from heat pumps (heating and cooling), highly-efficient boilers, electrical products, HEMS (Home Energy Management System) and stand-by electricity power reduction.

3.2 Commercial sector (buildings)

Like household sector, insulation improvements for buildings are assumed in the WWF Scenario. Highest standards for insulation of commercial buildings, introduced in 1999,

can reduce energy used in heating and cooling to 75% of that in buildings built with 1980 standards. Together with other efficiency technologies such as doubling the efficiency of air-conditioners by heat pumps, energy consumption for heating and cooling can be reduced to 37.5% of the current level in 2050.

Similar assumptions are made for lighting (replacing with LED), application of BEMS (Building Energy Management System), office computers and electric appliances, use of IT/tele-conferencing, urban greening, and "Cool/Warm Biz" styles

3.3 Industry sector

For industry, both cross-cutting technologies (e.g. inverter controlled motors) and area-specific technologies (e.g. more recycling and electric furnace use in steel) are assessed and assumed.

For instance, existing motors working at half-capacity are still using over 80% of the electricity they use when working at full load capacity. However, with an inverter installed, only necessary energy is consumed (roughly 30%). As almost all industries could benefit from inverter technology, and with greater interest in energy-saving due to increasingly expensive energy bills, the WWF scenario assumes that inverters will be widely adopted, increasing efficiency by 20~30% in 2050 in material-based industries.

Regarding steel industry, Japan has relatively large share of blast furnace compared to electric furnace (70% and 30% respectively). However, according to other calculations, global iron and steel recycling could rise to 90%. Following the trend, the WWF scenario assumes the proportion of recycled steel will rise from 30% in 2008 to 70% in 2050, reducing energy demand to 44.8%.

For other energy-intensive industries like cement, paper and pulp and chemicals, combination of various technologies are assumed to contribute 30% improvement of efficiency.

3.4 Transport sector

The most important assumption in transport sector in the WWF Scenario is a transition from existing vehicles to Plug-in Hybrid Vehicles (PHV), Electric Vehicles (EV) and Fuel Cell Vehicles (FCV). Together with lightweight of vehicle bodies, the transition to EV/FCV is calculated to result in reducing the energy consumption to 30% of vehicle sub-sector of the transport. Since it is difficult to assume the share of EV and FCV, 50% is assume for each.

Other technologies and measures assumed for transport sector include car-sharing, "Eco-drive" practice (environmentally friendly driving), improvement of fuel economies of existing vehicles and modal shift (from truck transport to rail and shipping), lightweight aircraft, efficient ships and combination of measures for rail.

4. Policy recommendations

Technologies and measures laid out in the WWF Scenario require strong policy support.

4.1 National efficiency Target

In order to have clear direction of energy efficiency policies, it is vital to have mid-/long-term targets for energy efficiency. Following the results of the WWF Scenario, the following indicative targets in Table 3 should be considered.

Table 3. Energy efficiency targets expressed as reduction rate from the 2008 level

	2020	2030	2040	2050
Energy Efficiency Target (Rate compared to 2008)	-20%	-30%	-40%	-50%

Source: WWF Japan.

4.2 Mandatory policies for industrial efficiencies

The existing non-mandatory intensity targets under the Energy Conservation Law will not be sufficient to achieve the high efficiency in industry sector assumed in the WWF Scenario. Stronger policies are needed.

Ideally, introduction of cap and trade to drive both energy efficiency measures and climate measures.

At least extending the *Top Runner Program* to factories should be considered. The current Top Runner Program require home appliances to meet efficiency standards set based on the most efficient products in the market. This logic should be applied to manufacturing factories, especially energy intensive ones.

4.3 Building codes for energy efficiency

Unlike many other developed countries, energy efficiency standards for new buildings have not been made mandatory in Japan yet. In some countries, there is even ongoing discussion on the necessity of mandatory requirements for *existing* buildings.

The Japanese government is now aiming at having new mandatory efficiency standards by 2020, though it is not yet clear whether the standards will be in fact mandatory. If we are to achieve the complete transition of all the buildings to at least the level of the existing efficiency standards by 2050 as assumed in the WWF Scenario, having mandatory standards for new buildings is crucial and, ultimately, having building standards for existing building (i.e. compulsory reform) might be necessary, too.

4.4 Integration of energy efficiency perspective in urban planning and town development

To achieve the complete transition to EV/FCV and the huge modal shift assumed in the WWF Scenario, energy efficiency perspective need to be integrated in urban planning and town development. Infrastructure in Japan will require significant reforms anyway due to the aging and also to decreasing population. A key challenge here is whether energy efficiency perspective can be appropriately embedded in the general planning for such transition of infrastructure.

The above recommendations are by no means exhaustive but they are vital to achieve the efficiency improvements estimated in the WWF Scenario. WWF Japan will continue to explore necessary policies and advocate for them accordingly.