Impacts of public acceptance and willingness to pay on achieving target of renewable energy resources in Japan

Lu GAO*, Yuki HIRUTA and Shuichi ASHINA, National Institute for Environmental Studies, Japan

1. Introduction

- Japan decided a GHG reduction target of 18% by 2030.
- To achieve this target, electricity production by renewable energy resources expect to play a key role
- Although the higher capital cost for renewable energy, there is a movement to defray the additional cost, impacting their further diffusion
- We have developed series of models to simulate, How well the WTP will impact on the renewable energy?

2. Description of Data

- Key word: WTP, Japan, CVM +renewable, green, electricity, power, wind, solar, photovoltaic and hydro

Author	Survey Year	Survey Area	WTP	Object analyzed
Nomura and Akai (2004)	2000	Japan	1956	WTP for promoting renewable
Nomura (2009)	2001	Japan	1893	WTP for promoting renewable
Baba and Tagashira (2002)	2001	Kagoshima	239	WTP for promoting green electricity
Teraoka (2002)	2001	Tohoku, Kanto, Kyushu	1199	WTP for promoting renewable
Fukae (2003)	2002	Fukushima, Niigata, Fukui, Tokyo, Osaka	279	WTP for supporting utility investment in solar power
Takahashi and Nakagome (2004)	2002	Kanto, Kansai	1445	WTP for promoting renewable
Ise (2006)	2005	Japan	5410	WTP for promoting 100% wind power
Ito et al. (2012)	2005	Japan	1311	WTP for investment in solar power
Tagashira and Baba (2007)	2005	Tokyo	277	WTP for promoting green electricity
Goto and Ariu (2011)	2009	Japan	726	WTP for promoting 100% renewable energy
Matsuoka (2014)	2012	Hokkaido, Aomori, Ibaraki, Chiba, Shizhuoka, Wakayama, Kochi	421	WTP for promoting offshore wind power
Murakami et al. (2015)	2013	Japan	3037	WTP pay for 1% increase in renewable
Hironaka and Hondo (2017)	2015	Aichi, Shizhuoka	665	WTP for promoting renewable
Nakamura (2018)	2015	Nagano	576	WTP for mitigate climate change and to reduce reliance on nuclear power generation

3. Methodology

3.1 Estimation of WTP

☐ Meta-regression was used to forecast the WTP

$$WTP_{med} = f\,(Age, Gender, Income, Education, RE_{share}, YEAR)$$

Where *Age* is the average for target area, *Gender* is the percentage of female share within total population (%), *Income* is the annual average household income (JPY), *Education* is the percentage of the adult population held a university degree (%), Re_{share} is the percentage share renewables of total energy (%) and *YEAR* is the survey year

3.2 Estimation of Acceptability rate

① Baseline (Weibull distribution)

$$F_{base}(X) = \exp\left(-\exp\left(\frac{\ln X - a}{b}\right)\right)$$

Where F_{base} (X) is the base acceptability function, X is WTP in JPY/(household·month). a and b are assumed to 6.505 and 1.065.

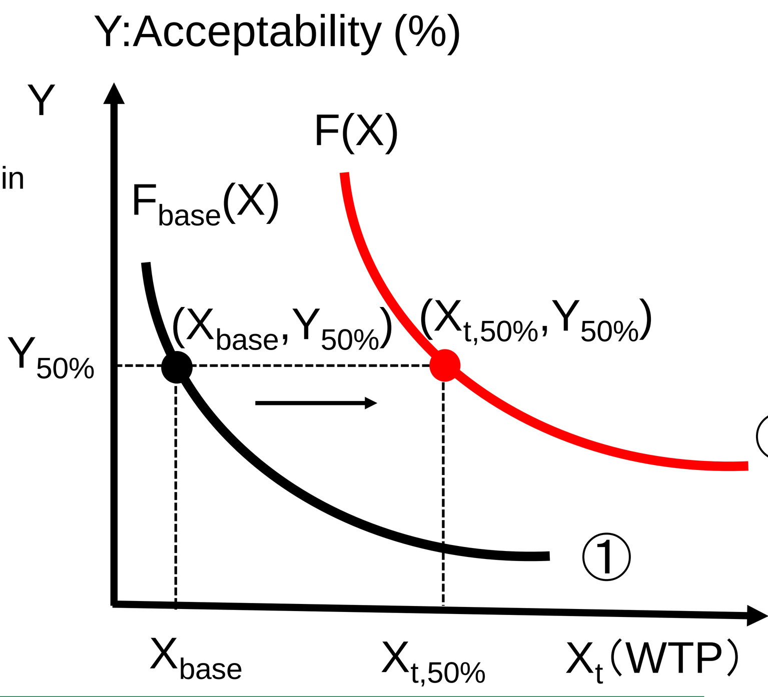
② Shift in acceptability curve

$$F(X) = \exp\left(-\exp\left(\frac{\ln(X_t - \alpha) - a}{b}\right)\right)$$

$$\alpha = X_{t,50\%} - X_{base} \qquad X_{50\%} = WTP_{med}$$

$$X_{base} = \exp(a + b\ln(-\ln(Y_{50\%})))$$

Where, *F(X)* is the acceptability function, $Y_{50\%}$ is acceptability rates in 50%, *X* is WTP in JPY/(household·month), t is the year

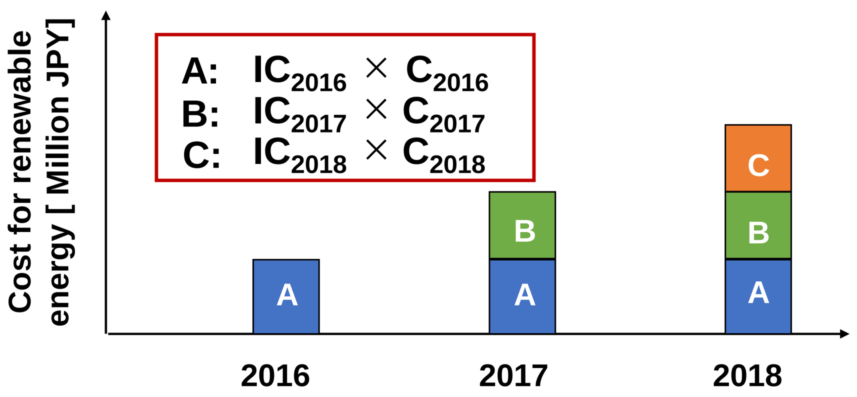


3.3 Estimation of Necessary Subsidies for RE

$$NS_t = (IC_{j,t} \times Cost_{j,t} + IC_{j,t+1} \times Cost_{j,t+1}) \times \frac{i \times (1+i)^n}{(1+i)^n - 1} - \max(TWTP)$$

TWTP = WTP × Household × Acceptability rate

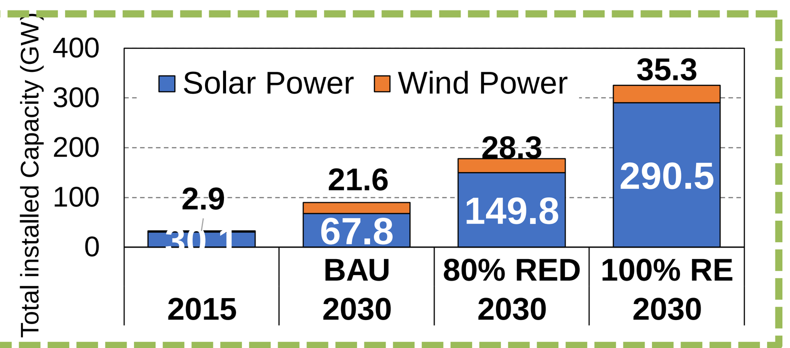
NS_t { < 0 Subsidies is necessary; > 0 Subsidies is unnecessary



Where *NS* is annual necessary subsidies in JPY/year, *IC* is the increased installed capacity for renewable, kW. *Cost* is the capital cost for renewable energy, TWTP is the total willingness to pay

4. Future Scenario Setting

- Installed capacity for RE
  - ✓ **BAU**: Development patterns as the past
  - ✓ **80% RED**: 80% reduction in GHG
  - ✓ **100% RE**: All of energy is supplied by RE



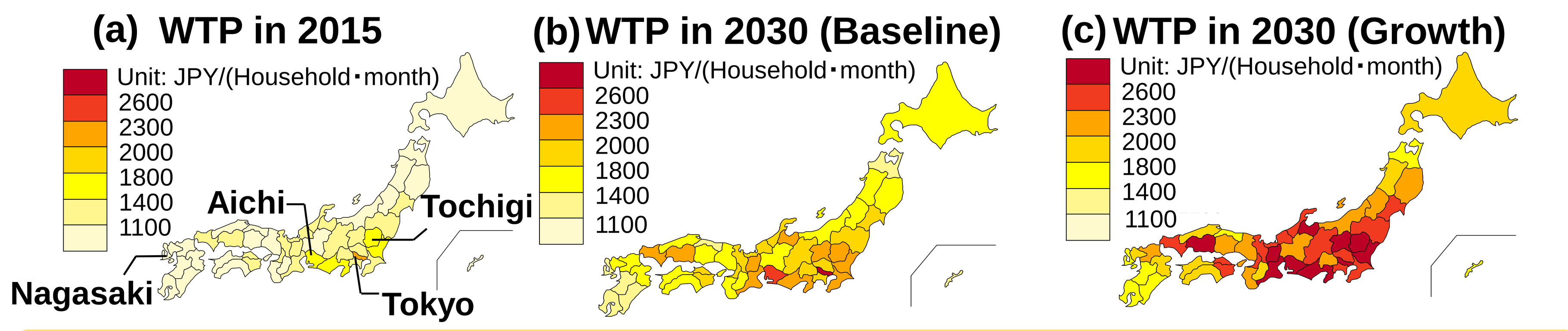
- Socioeconomic condition
  - ✓ **Baseline**: Economy will grow at the rate of current potential growth
  - ✓ **Economic Growth Achieved Case**: policies of Abenomics for overcoming deflation and attaining economic revitalization

- Policy scenario

	Ref (WTP = 0)	WTP (Baseline)	WTP (Growth)
Constant Capital cost	Scenario 0		
Capital Cost Reduction	Scenario 1	Scenario 2	Scenario 3

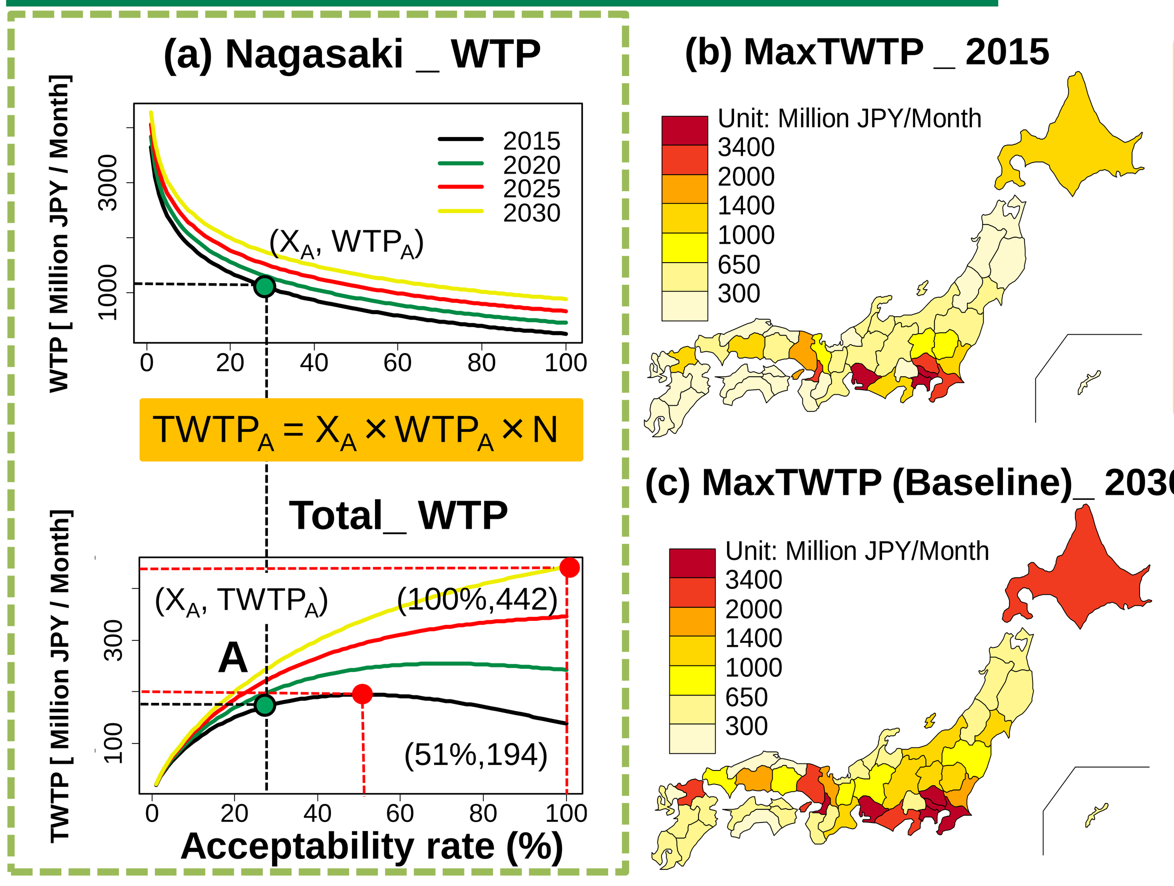
5. Result and Discussion

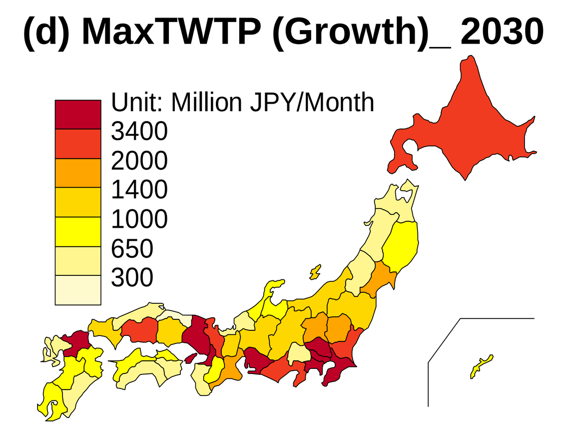
5.1 Prediction of the medium value of WTP



- Median value of WTP increase from 1,200 to 2,200 JPY/(Household・month)
- WTP is higher in Tokyo, Aichi, Tochigi → a higher income
- WTP in baseline is less than in economic growth achieved case

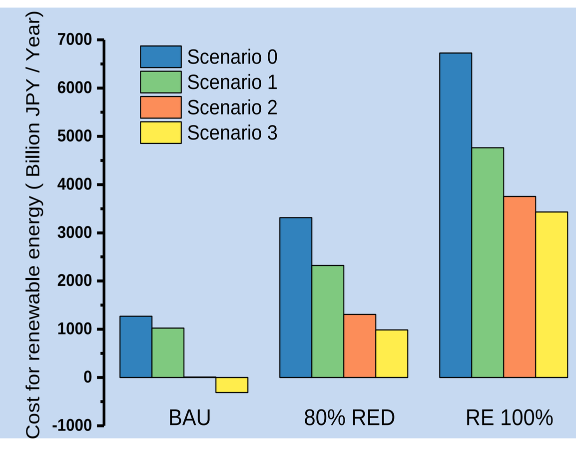
5.2 Prediction of total WTP



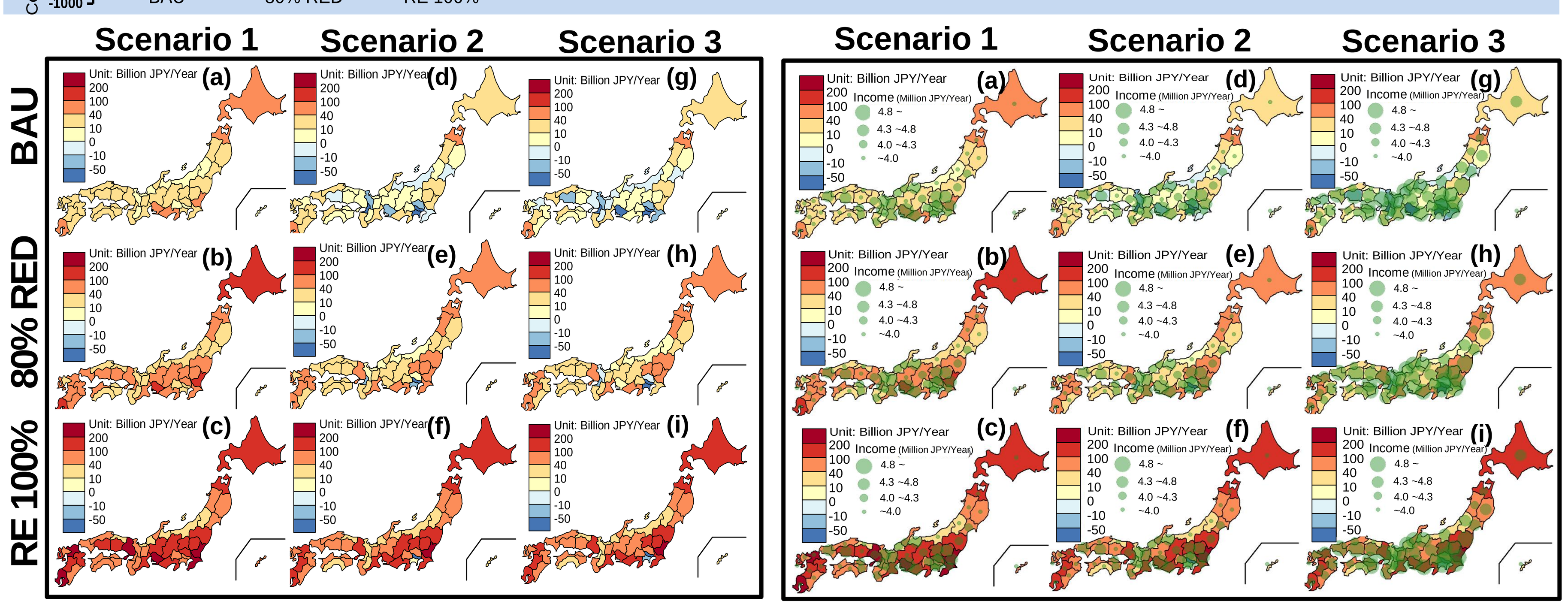


- For example, In Nagasaki, the maximum value of WTP is increasing from 194 to 442 million
- The maximum value of WTP is increased by 1.8 to 2.3-fold

5.2 Cost gap for renewable energy



- Annual cost for increasing the renewable energy are expected to be within 1.3 × 10^3 ~ 6.7 × 10^3 Billion
- These costs will decrease to 1.0 × 10^3 ~ 4.8 × 10^3 Billion, attributing to the reducing of production cost
- Both considering the reduced production cost and WTP, these costs will continued **decrease** to -0.3 × 10^3 ~ 3.8 × 10^3 Billion



- For Tokyo, Kanagawa and Osaka, additional investment subsidy for renewable energy is unnecessary
- In the scenario 3, the number of the area which require subsidies are lower than that in scenario 2 → a higher income

6. Conclusion and future work

- From 2015 - 2030 { Median value of WTP → increase from **1,200 to 2,200** JPY; Maximum value of TWTP → increase from **0.5 × 10^3 to 1.1 × 10^3** billion JPY

☐ Future work

- ✓ **Expand** the method into **other countries or areas**
- ✓ Evaluation the impact of WTP on energy use **by models**

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