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Measurement of Economic Impact and Cost Benefit Analysis on National R&D Program at NEDO

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1. Introduction

- Quantitative information of the outcomes is required to explain the accountability for the public R&D projects.
- NEDO has been trying to grasp the outcome of the projects and the correlations among them through the follow-up monitoring. However, the quantitative analysis of the "additional" effects (additionality) of R&D projects conducted by NEDO have not been taken so far.

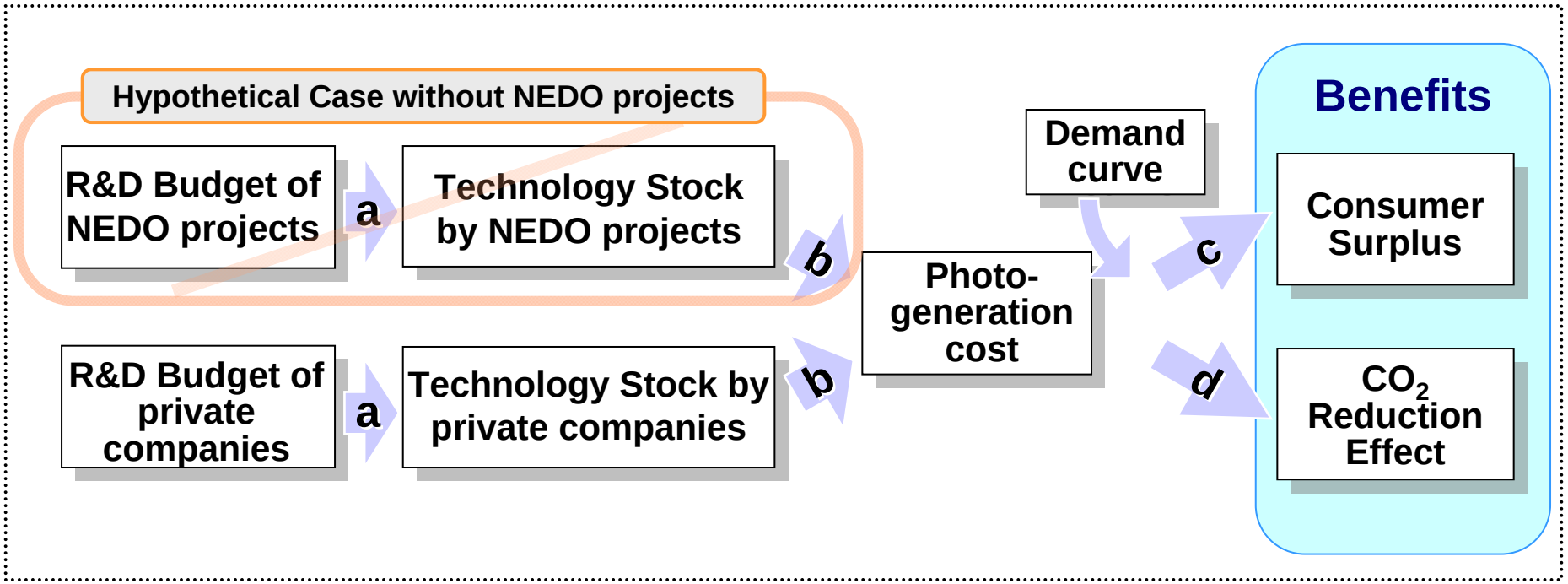
- In this research, we established the method to estimate the social and economic "additionality" of the NEDO projects.

2. Methods

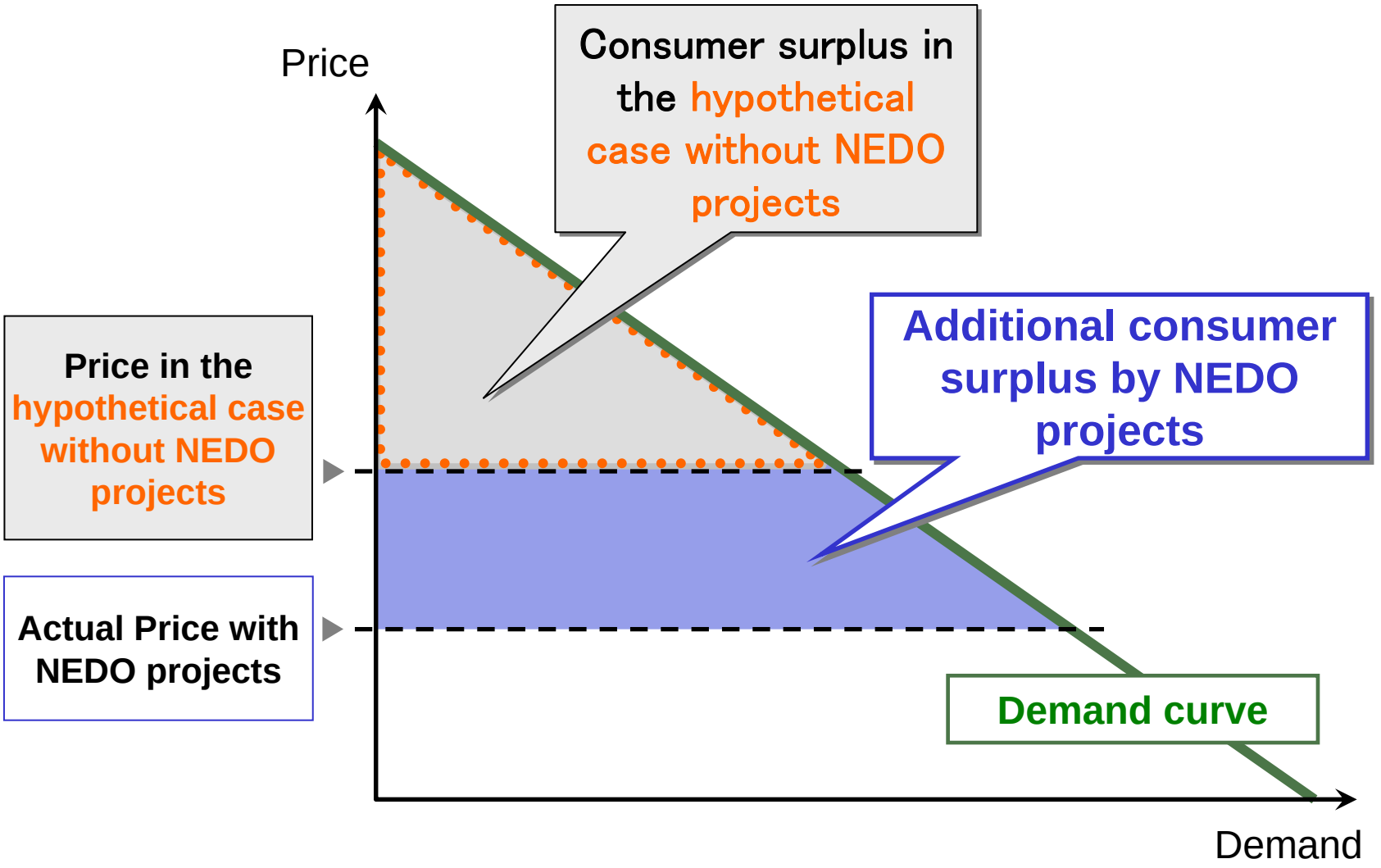
Case

NEDO R&D projects on Photovoltaic (PV) cells

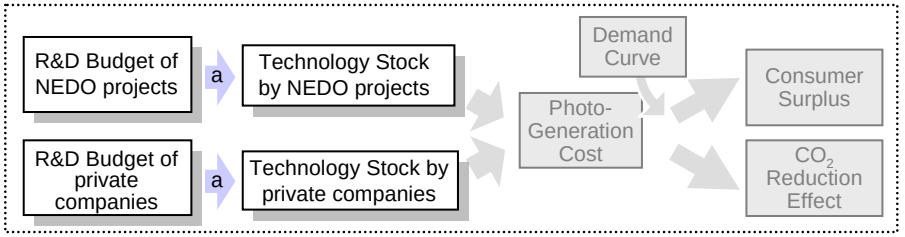
Logic



2. Methods


Price
Consumer surplus in the hypothetical case without NEDO projects
Additional consumer surplus by NEDO projects
Price in the hypothetical case without NEDO projects
Actual Price with NEDO projects
Demand curve
Demand

3. Estimation of Technology Stocks



A model to estimate Technology Stocks

R&D budget provided *m* years ago that generates new TS

$$TS_t = TS_{t-1} \times (1 - dep) + \frac{PRB_{t-m}}{def}$$

TS of the previous year

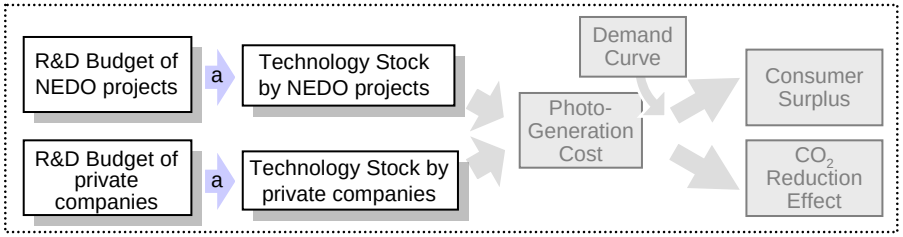
Rate of Technology obsolescence

Deflator

TS : Technology Stock
t : Time (year)
m : Time Lag = 2 years
dep : Rate of Technology obsolescence = 10.3%
PRB : R&D Budget of NEDO or Japanese private companies* for PV tech.
def : Deflator

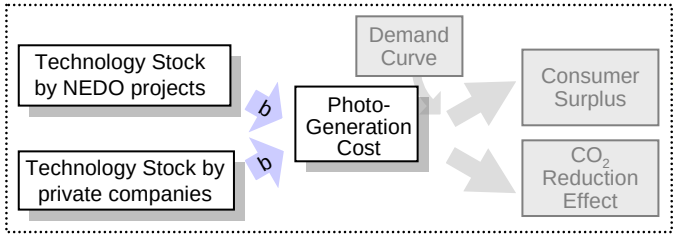
* "Survey of Research and Development" by Statistics Bureau, Ministry of Internal Affairs and Communications

3. Estimation of Technology Stocks



Technology Stocks of NEDO projects and R&D of private companies

4. Simulation of the Photo-Generation Cost



Correlation of TS and module cost of photovoltaic cells

$$Ln(PVC) = 15.735 - 0.107\,Ln(TS_{(NEDO)}) - 1.057\,Ln(TS_{(PS)}) - 0.152\,Ln(PVP)$$

- PV module cost
- Technology Stock by NEDO projects
- Technology Stock by private companies
- PV module production

Results of multiple regression analysis

	Regression coefficient	t statistics
Variable for TS(NEDO)	-0.10663	2.9181
Variable for TS(PS)	-1.05733	4.9419
Variable for PV production	-0.15212	8.3211
Constant	15.73473	13.0929
Adjusted multiple correlation coefficient	0.9866	
Durbin-Watson statistic	1.6151	

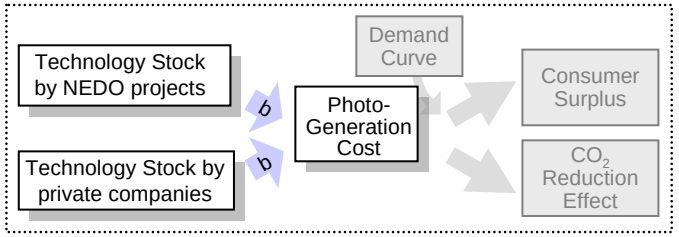
Assumptions of hypothetical case without NEDO projects

<Assumption 1> No quantitative variation of the **$TS_{(NEDO)}$** since 1983

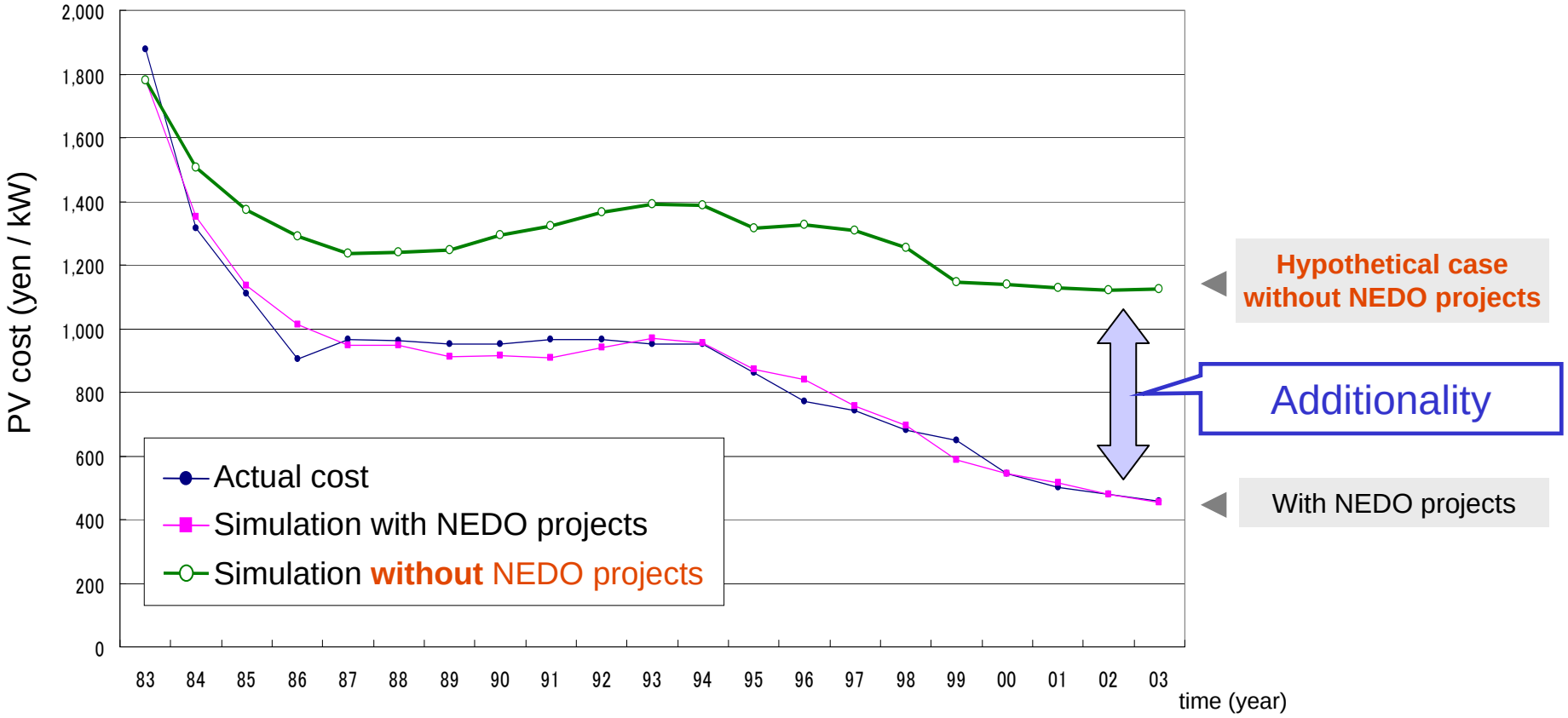
<Assumption 2> No quantitative variation of the **PVP** (photovoltaic production) since 1983*

*Based on the demand curve, we assumed that PV production would change little under the assumption 1.

4. Simulation of the Photo-Generation Cost



Simulated Module cost of PV cells



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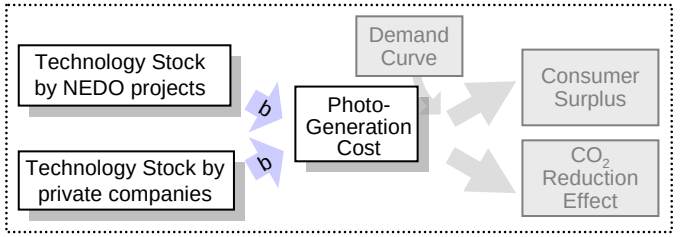
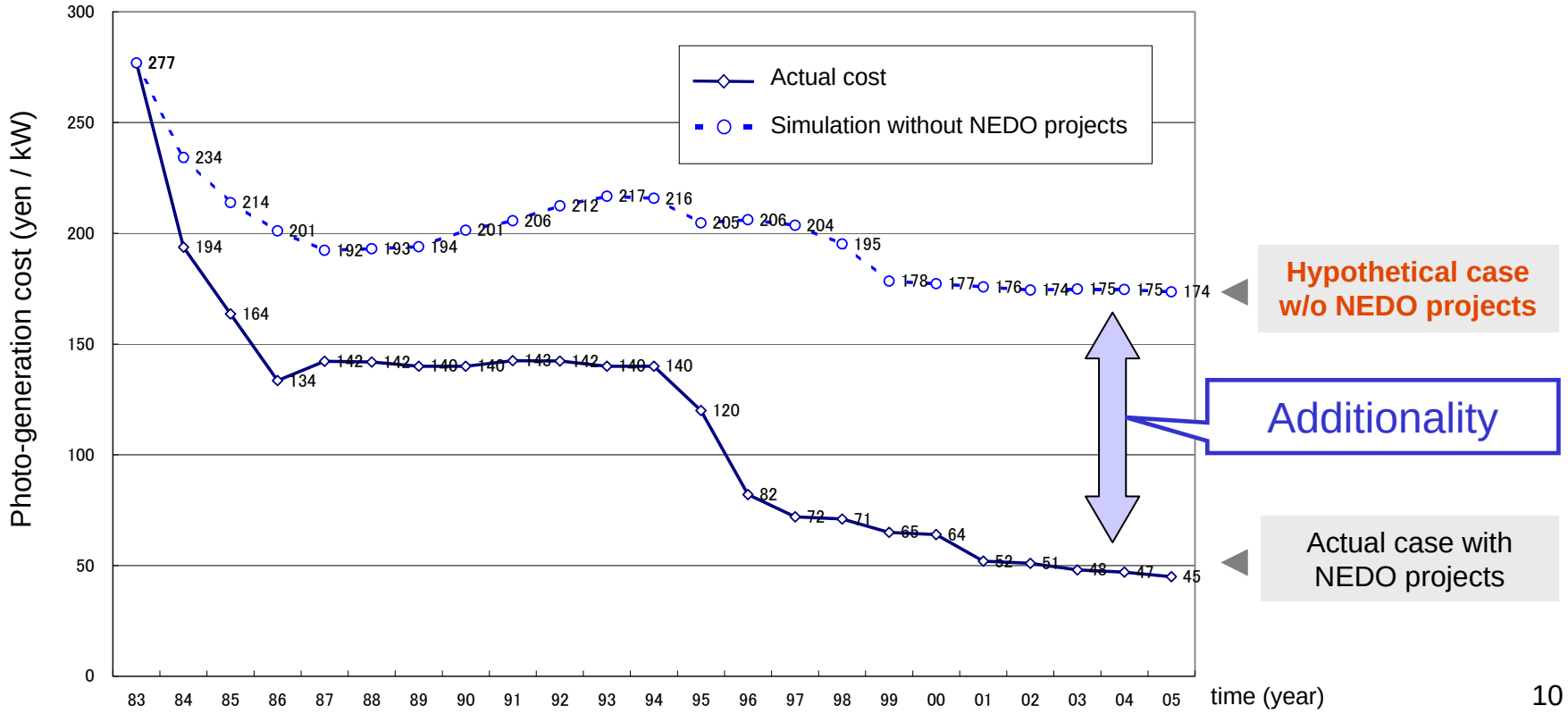


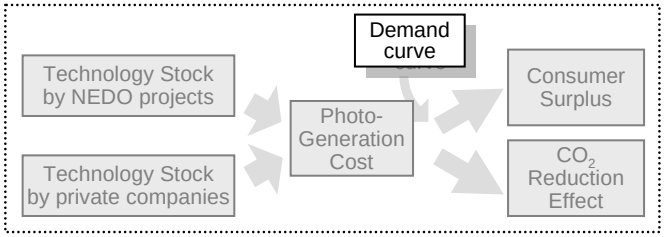
Photo-generation cost = System cost * Cost rate per year / Generated power per year

Annual cost rate = Interest / (1-(1+Interest)-durability)
Annual generated power = Generation capacity * 24h * 365d * Utilization rate

Simulated photo-generation cost



5. Estimation of the Demand Curves

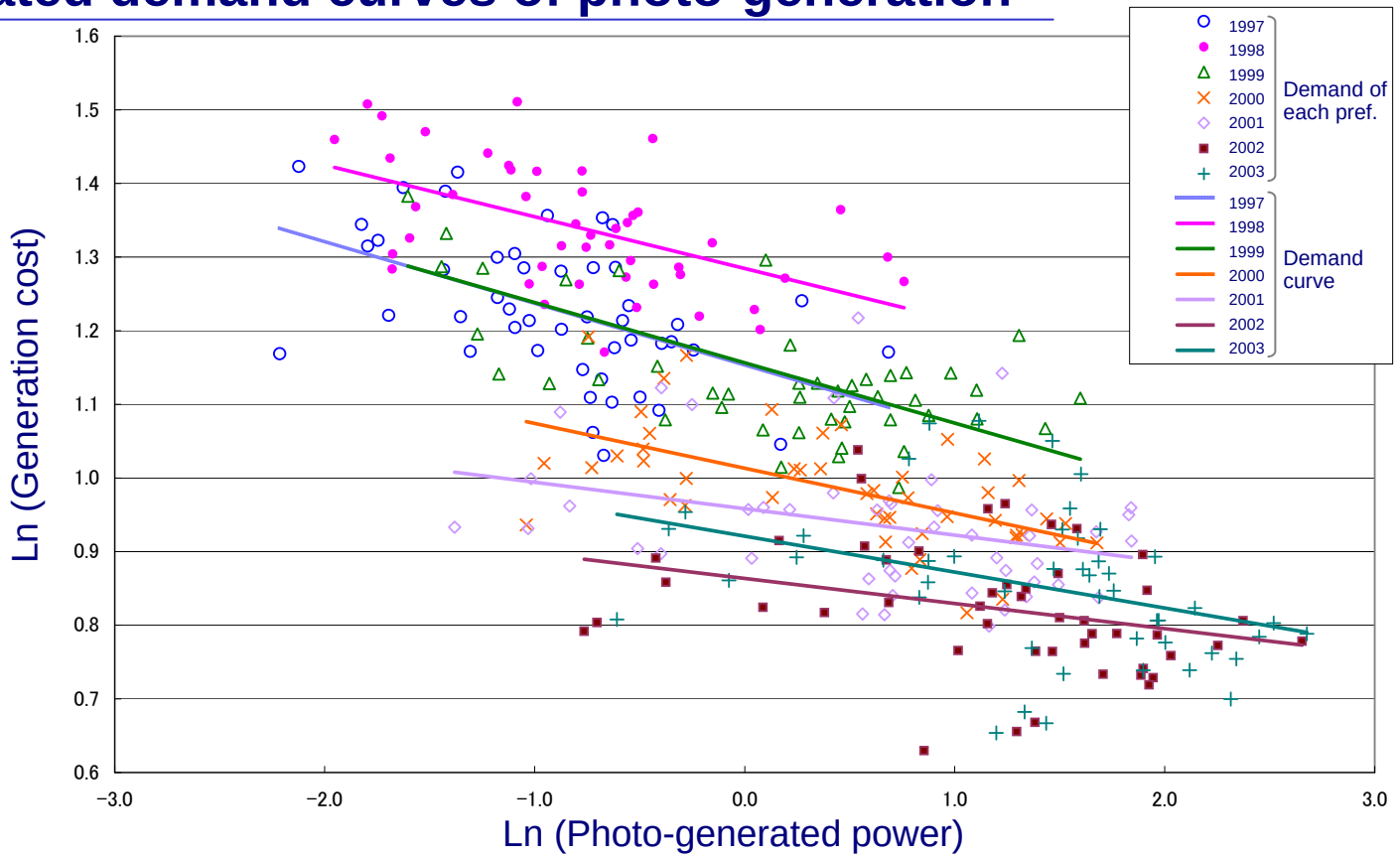


Demand curves are estimated by plotting the generated power and photo-generation cost per year in each of 47 prefectures in Japan.

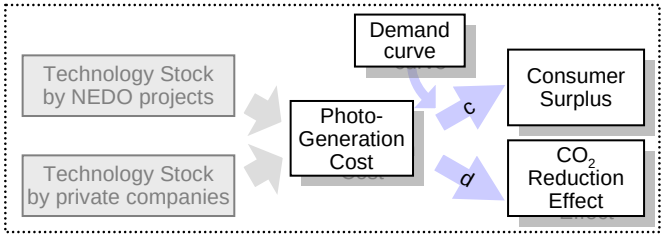
$$W_t = H_t * def_t^{14.2} * I_t^{0.496} * pp_t^{-9.81} * p_t^{-4.85} * e^{-0.104t+192}$$

W : Photo-generated power
def : Deflator
H : Number of households
I : Income of a household
pp : Power purchase price
p : Power generation cost

Estimated demand curves of photo-generation

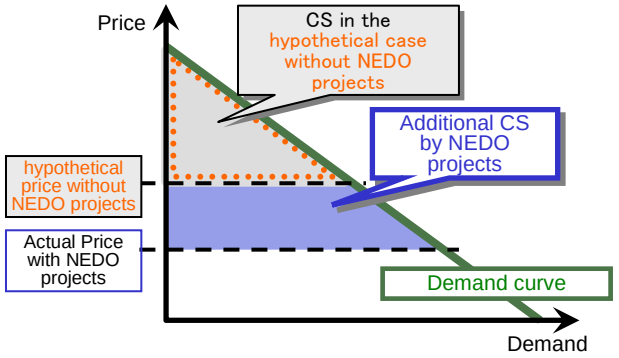


6. Estimation of the Benefits



Procedures to estimate consumer surplus (CS)

Consumer surplus of every single year is estimated by integrating equations for demand curves.

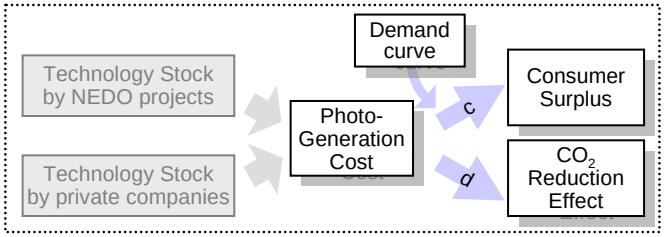


Procedures to estimate CO_2 reduction effect

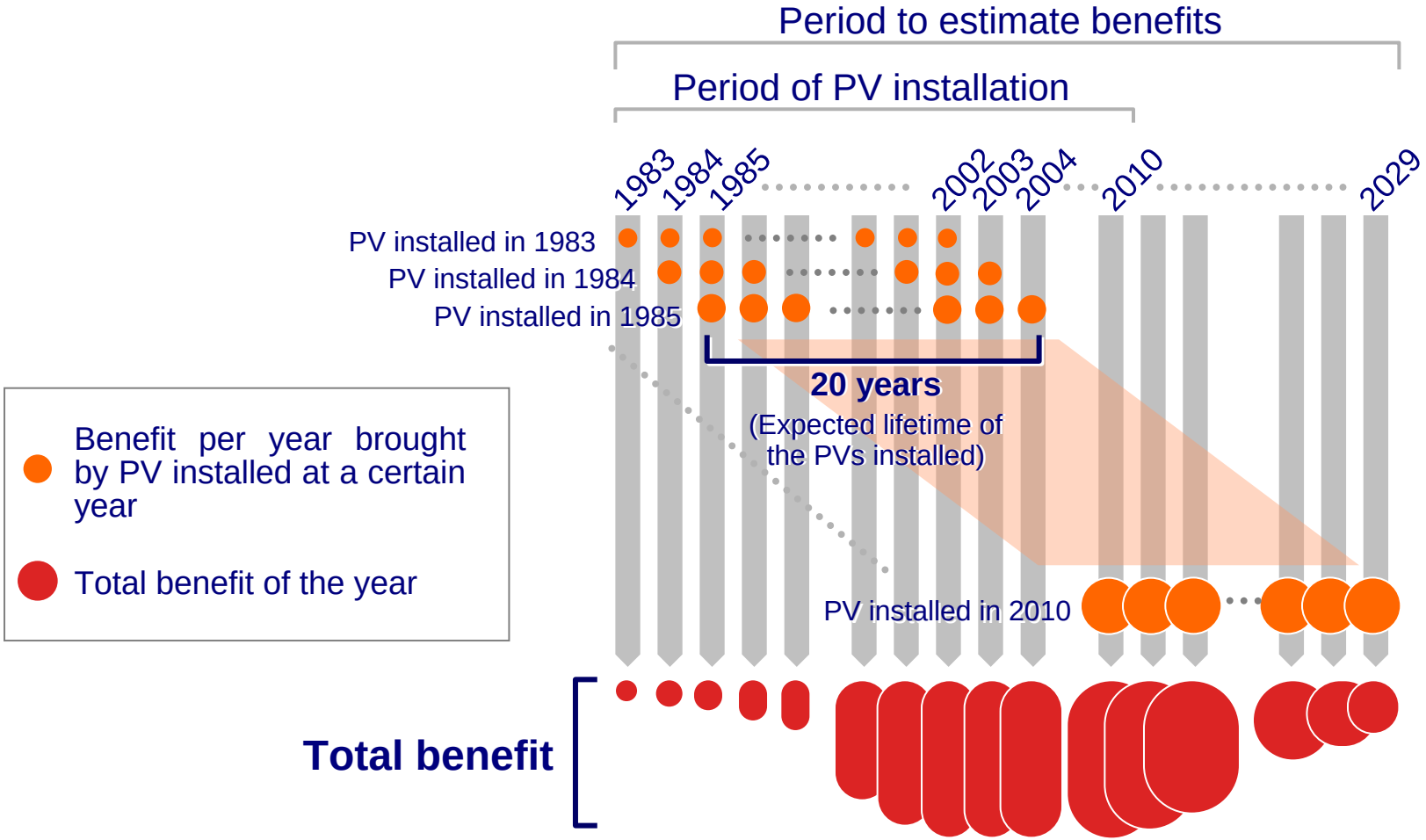
CO_2 reduction effect per year
= Photo-generated power per year * Emission Intensity of PV * Carbon credit price

a. Photo-generated power is estimated by demand curves and photo-generation cost.
b. Emission intensity of PV = 0.378kg-CO_2 / kWh
c. Carbon credit price on Emission Trade system = 1,212 yen / kg-CO_2

6. Estimation of the Benefits



Procedures to calculate the total benefit



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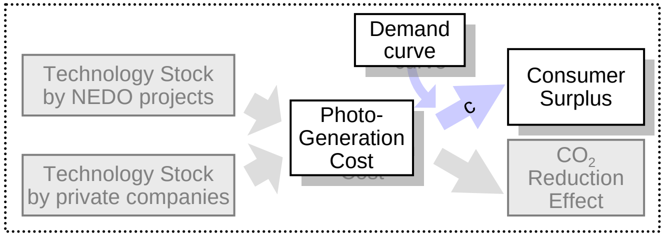
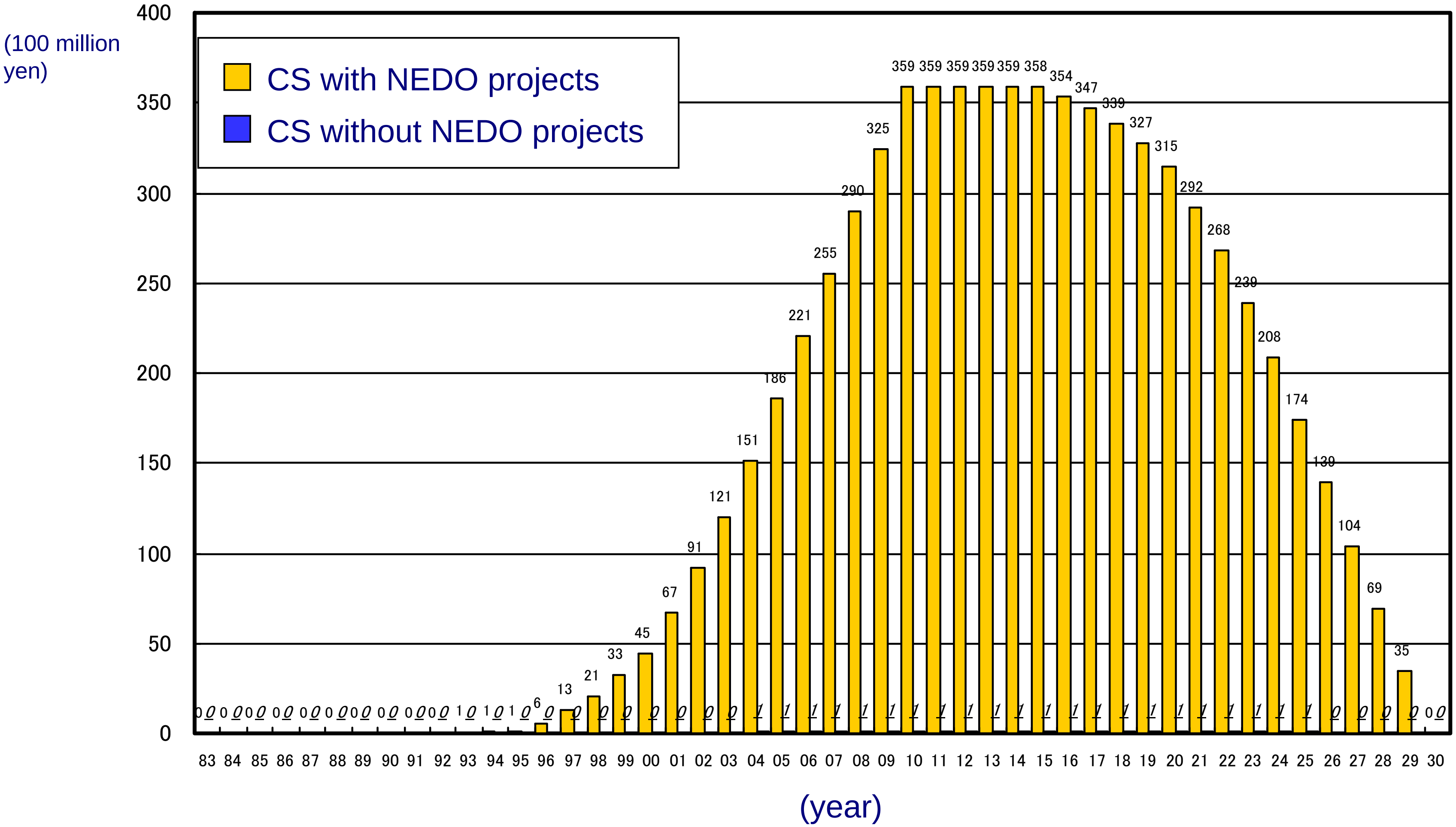


Estimated consumer surplus



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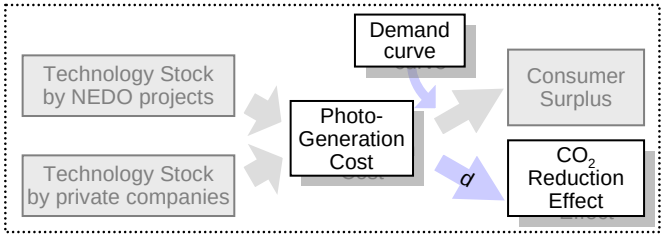
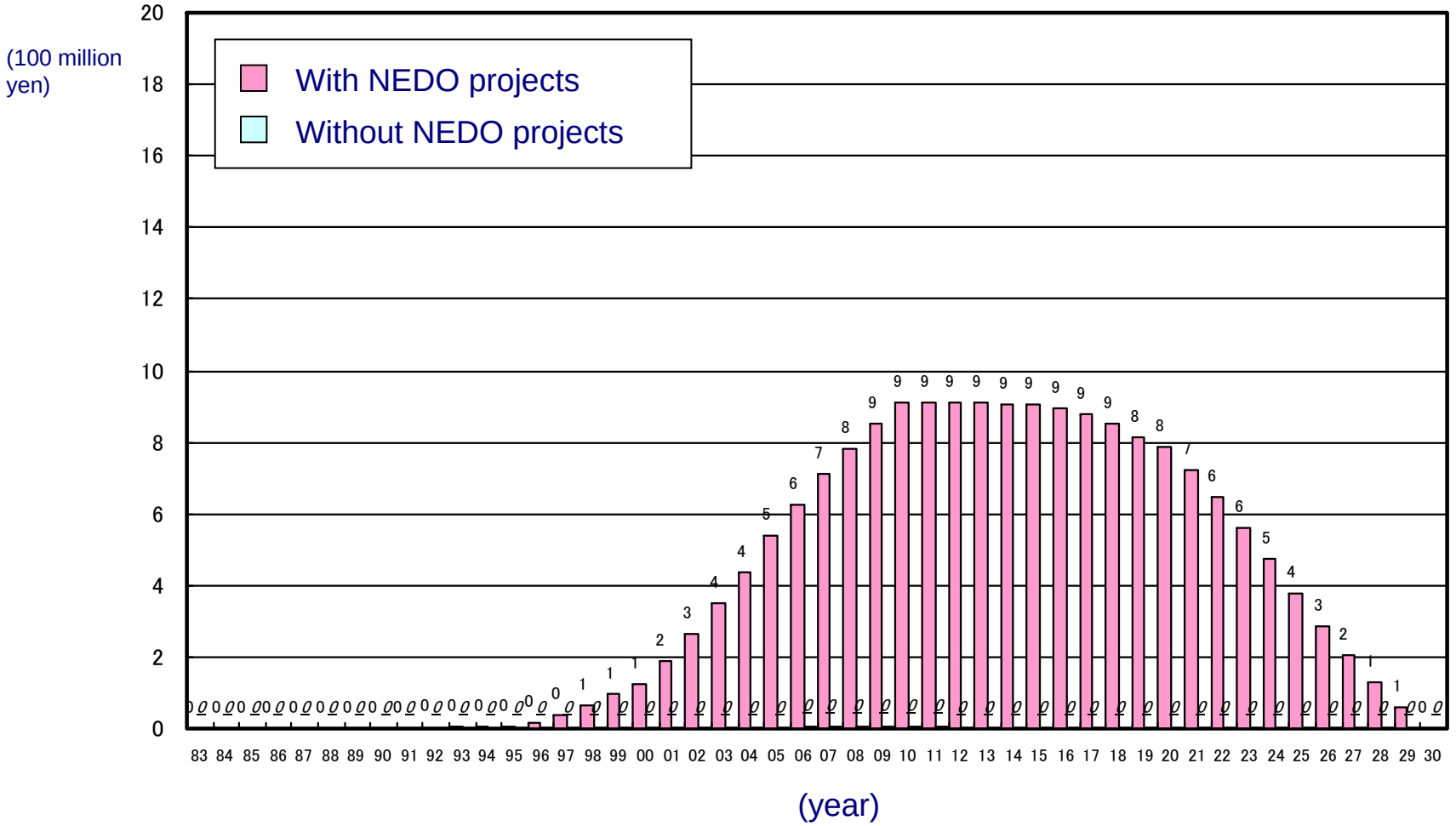


Estimated CO_2 emission reduction effect



7. Result of Cost-Benefit Analysis

Estimation of Net Present Value (NPV) at 2005

$$NPV_{2005} = \sum_{t=1983}^{2029}\left(B_{pt} - C_{pt}\right) = \sum_{t=1983}^{2029} B_{pt} - \sum_{t=1983}^{2029} C_{pt}$$

B_{pt} : Benefit of NEDO projects
= Additionality on CS + Additionality on CO_2 reduction effect

C_{pt} : Cost of NEDO projects

Discount Rate = 4%

(Billion yen)

Cost	Benefit			NPV
		Consumer surplus	CO_2 reduction effect	
270	527	514	13	257

8. Areas for Improvement

General points (Methods and Logics)

- Technology obsolescence rate and the duration of time lag might be different.
- Input additionality, spillover effect, and producer surplus were not considered.

Points specific to this PV R&D case

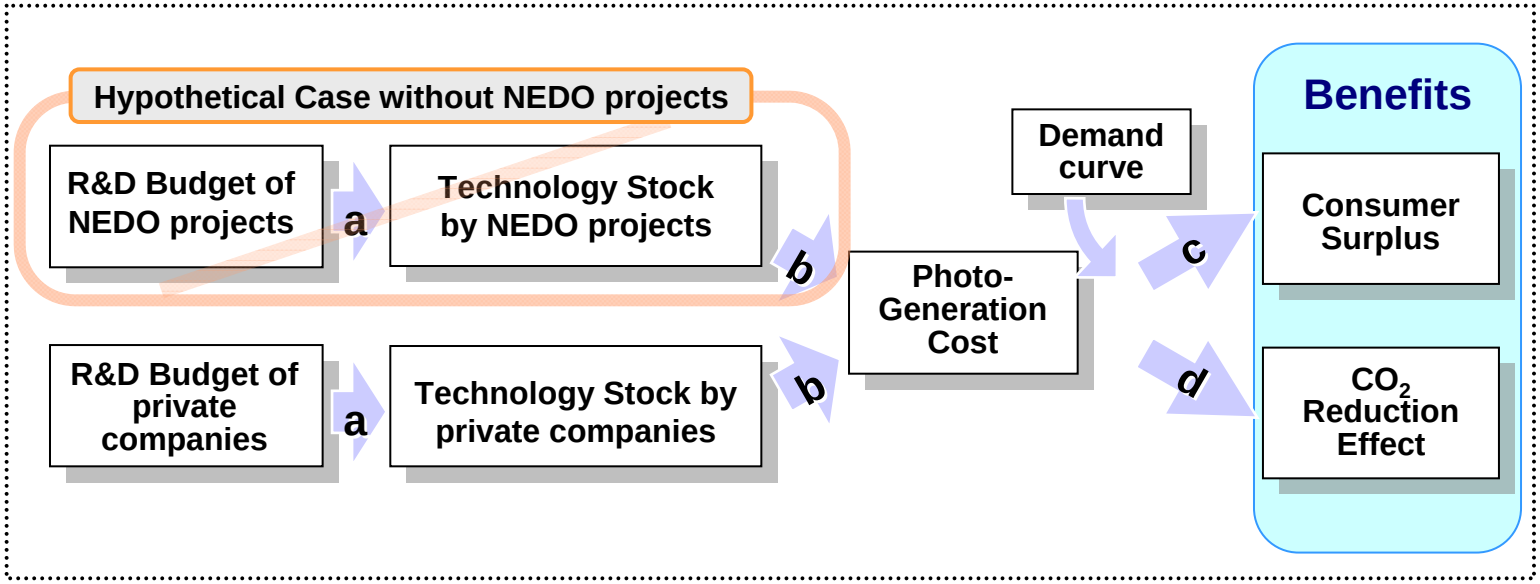
- PV production under the hypothetical case without NEDO projects
- PV installation incentives and benefit as improvement of Japan's energy self sufficiency were not considered.

Applicability to other projects

- Data availability
- Applicability to the non-market value (*e.g.* medical technology)

9. Conclusion

We have established a model to estimate the additionality of the public R&D projects. However, accuracy and versatility of this model need to be improved further for actual project evaluation in the future.



Acknowledgement

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Thank you for your attention.

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