**Asia and the Pacific Transport Forum 2024**

# Logistics technology that balances food freshness preservation and decarbonization

Shizuoka Sangyo University
Associate Professor, **TAKENORI Iwamoto**
Ph.D. in Engineering

# **Self-Introduction** : TAKENORI Iwamoto

Shizuoka Sangyo University

## Areas of Expertise

- **Social Engineering**
- **Marketing**
- **Mobility Design**
- **Well-being**

Ph.D. in Engineering, Kyoto University

# **Self-Introduction** : TAKENORI Iwamoto

Shizuoka Sangyo University

Shizuoka Sangyo University

***A university specialized in regional industry innovation and problem-solving.***

# Self-Introduction : TAKENORI Iwamoto

Shizuoka Sangyo University

## Shizuoka Pref. Fujieda City


# *Cold Chain Logistics*

It is a joint venture between South Japan Transport & Warehouse Co.,Ltd and DENBA JAPAN Co.,Ltd

# DENBA DISS (株)

**Established in November 2020**

MTLS GROUP × DENBA+

**Temperature Management Logistics**

**Freshness maintained Technology**

## Next Generation Cold Chain

### Logistics Partners
ジャパンフローズンネットワークメンバー 全36社

日幸産業運輸 / 新潟食品運輸 / 増田運輸 / 荒木運輸 / -30℃ 神山運輸 / 関西トランスウェイ / 瀬野川産業 / 鶴見運送 / 園田陸運 / ・・・他27社

### Material Partners
Toprec トプレック
菱重コールドチェーン
KONG 金剛産業

### Forwarder Partners
NAX JAPAN Co., Ltd.

### System Partners
株式会社ファーストオーダー

### Funding
ITOCHU 伊藤忠商事
SBI Holdings

### Material Partners
CIMC 世界最大コンテナ製造メーカー
TITAN CONTAINERS 世界最大コンテナレンタル社
THERMO KING
HOSHIZAKI
DAIKIN

### Research Partners
東京大学 THE UNIVERSITY OF TOKYO
筑波大学 University of Tsukuba
慶應義塾 Keio University

Shizuoka Sangyo University

DENBA+

DENBA Japan

**TAKENORI Iwamoto Lab**

# Topics

Shizuoka Sangyo University


# Challenging High Energy Consumption Through a Cold Chain System Utilizing New Freezing Technology

# Sub-Topics

Shizuoka Sangyo University

1. Technology of DENBA

2. Conventional Wisdom on Freezing Preservation and Power Consumption

3. Future Challenges and Expectations

# 1. Technology of DENBA

**DENBA+** is a food preservation technology, which **giving  a vibration to water molecules**.

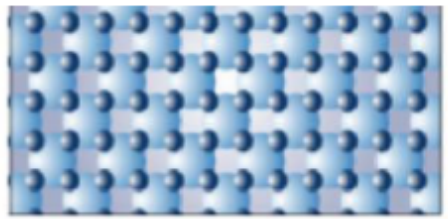
The **freshness** of the food is **kept longer** and the **production of bacteria is suppressed**, which contributes **the food loss rate to become significantly lower**.


Under **DENBA+** freezing process, **a round shaped crystals are formed instead of having sharp needles** (see right comparison picture).

These round shape **avoid destructing cell membranes** during the freezing process, which shall **reduce substantial amount of drip when food are thawed.**

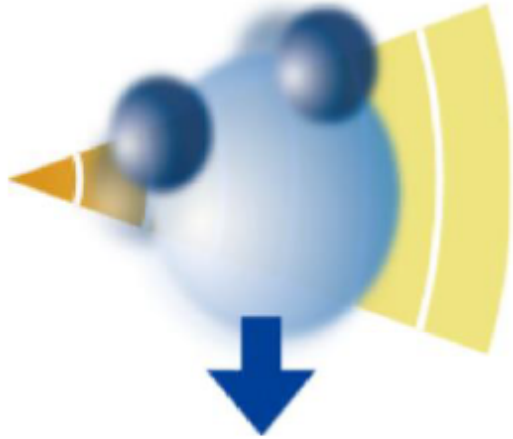
Normal water molecules

Water molecules are connected to each other

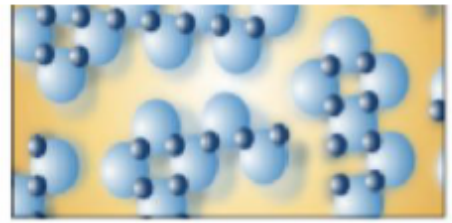


Iced water molecules with sharp needles.

Micro-vibrations were given to water molecules through space potentials.



Crystals of ice do not form until the temperature drops below -4℃.



Iced water molecules in round shape.

# Applications of Freshness Preservation Products

**In three stages of heat retention, refrigeration, and defrosting, you can maintain the freshness and quality of materials at an improved level.**


**Refrigeration** — Preserves freshness, inhibits functions of ingredients

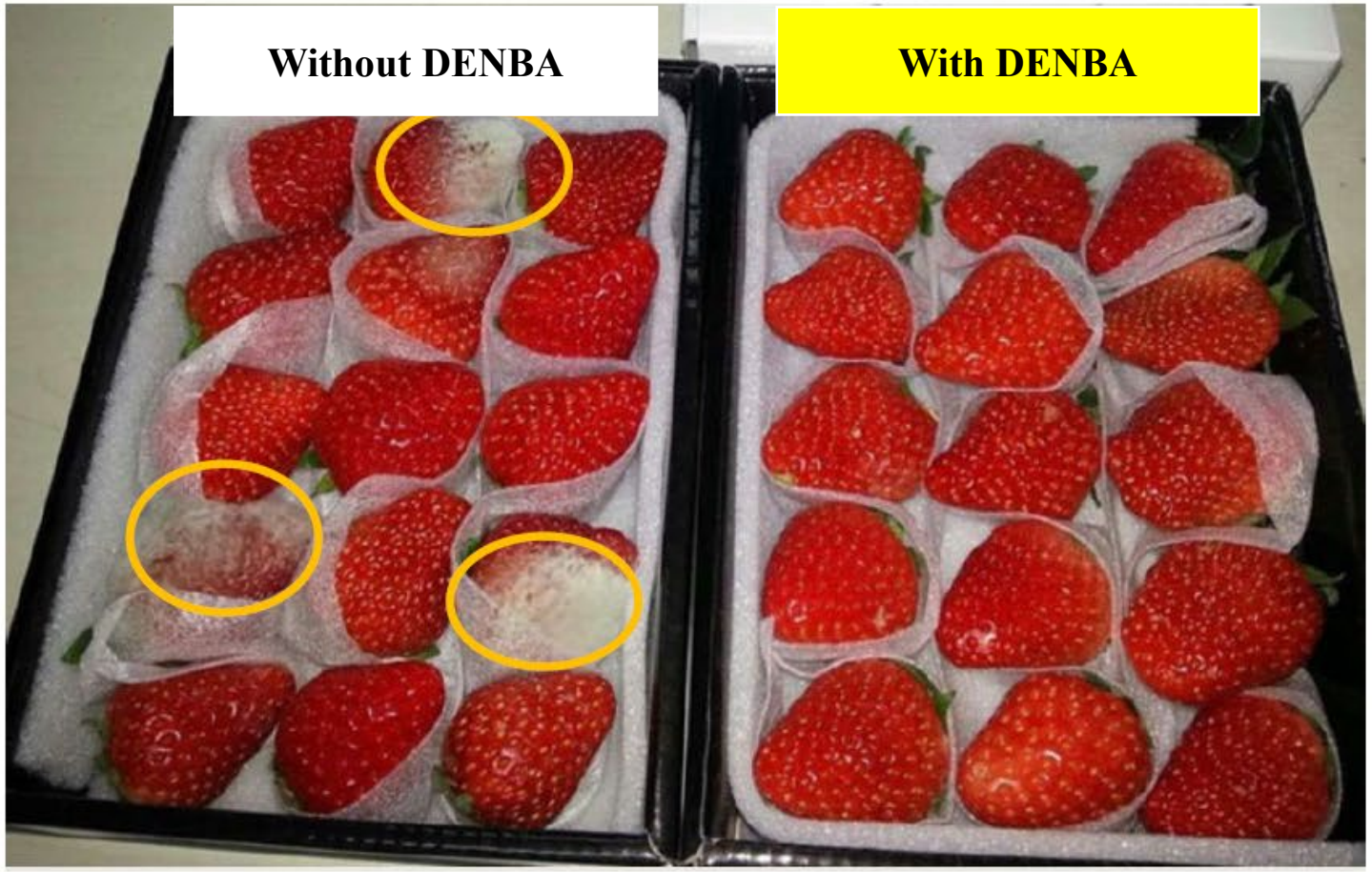
**Freezing** — High-quality freezing at -18° C to -25° C

**Defrosting** — Significantly reduces drip, improves quality and hygiene

# [Case] In the case of strawberries

**No mold growth, extended freshness preservation period**

**From the usual 2 days → Achieved 10 days of storage**




DENBA products prevent mold and extend freshness."

# [Case Study]

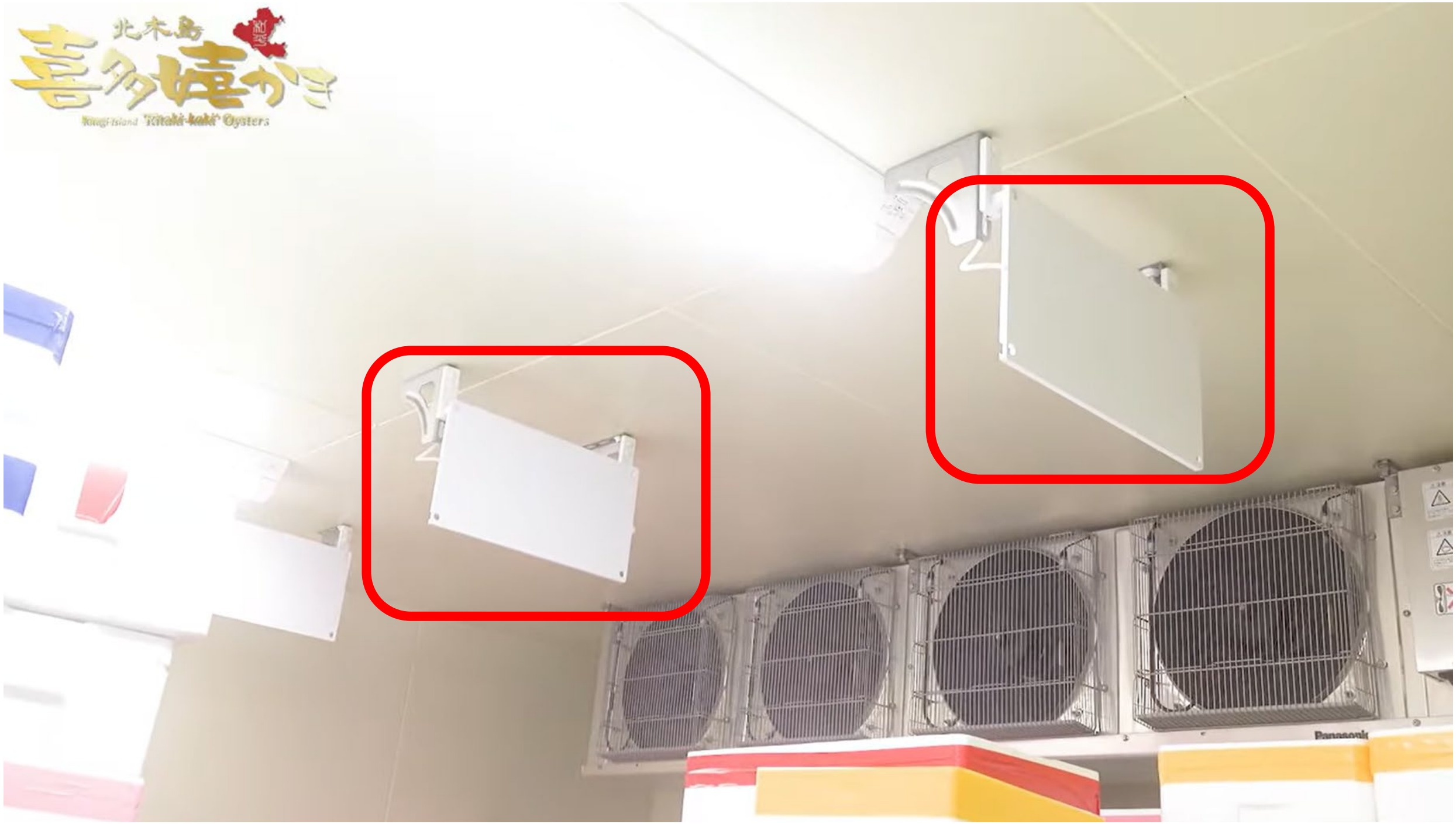
# Refrigeration of oyster production area

**Without DENBA**

**Looseness** observed in the oyster's adductor muscle, gills, and flesh

**With DENBA**

**Firmness** observed in the oyster's adductor muscle, gills, and flesh


北木島
喜久地かき
Kitaki-kaki Oysters
Panasonic


https://www.youtube.com/watch?v=GTiDzsIMVc8&t=189s

# 2. Conventional Wisdom on Freezing Preservation and Power Consumption

# Comparison of Coefficient of Performance Based on Warehouse Temperature

冷却能力特性

（記号）Q：能力
W：消費電力

| 機種名 | 電源周波数 | 周囲温度 | 庫内吸込空気温度 ℃DB | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | −35 | | −30 | | −25 | | −20 | | −15 | | −10 | | −5 | |
| | | | Q | W | Q | W | Q | W | Q | W | Q | W | Q | W | Q | W |
| | Hz | ℃DB | kW | kW | kW | kW | kW | kW | kW | kW | kW | kW | kW | kW | kW | kW |
| | 50 | 20℃ | 3.35 | 3.75 | 4.34 | 3.81 | 5.30 | 3.82 | 6.23 | 3.93 | 7.15 | 3.95 | 8.07 | 4.02 | 8.95 | 4.11 |
| | | 32℃ | 2.96 | 4.77 | 3.78 | 4.77 | 4.59 | 4.78 | 5.30 | 4.79 | 6.21 | 4.93 | 7.02 | 4.99 | 7.82 | 5.04 |
| | | 43℃ | 2.44 | 6.15 | 3.06 | 6.20 | 3.69 | 6.22 | 4.35 | 6.41 | 5.03 | 6.56 | 5.72 | 6.62 | 6.43 | 6.65 |
| | 60 | 20℃ | 3.35 | 3.83 | 4.34 | 3.87 | 5.30 | 3.91 | 6.23 | 3.98 | 7.15 | 3.99 | 8.07 | 4.07 | 8.95 | 4.16 |
| | | 32℃ | 2.96 | 4.85 | 3.78 | 4.87 | 4.59 | 4.89 | 5.30 | 4.90 | 6.21 | 4.97 | 7.02 | 5.04 | 7.82 | 5.09 |
| | | 43℃ | 2.44 | 6.26 | 3.06 | 6.28 | 3.69 | 6.34 | 4.35 | 6.46 | 5.03 | 6.61 | 5.72 | 6.66 | 6.43 | 6.70 |

そのまま試算

按分にて試算

| 庫内温度 ℃ | 冷凍能力 kW | 消費電力 kW | COP |
|---|---|---|---|
| -18 | 5.66 | 4.85 | 1.17 |
| -30 | 3.78 | 4.77 | 0.79 |

# Estimated Annual Power Consumption by Temperature Range

| 庫内温度 ℃ | 冷凍能力 kW | 消費電力 kW | COP |
|---|---|---|---|
| -18 | 5.66 | 4.85 | 1.17 |
| -30 | 3.78 | 4.77 | 0.79 |

◆概算負荷

| 広さ (坪) | 容積 ($m^3$) | 庫内温度(℃) 湿度80% | | | | |
|---|---|---|---|---|---|---|
| | | −10 | −15 | −20 | −25 | −30 |
| 1 | 6.1 | 0.78 | 0.86 | 0.97 | 1.05 | 1.19 |
| 1.5 | 9.6 | 1.11 | 1.23 | 1.39 | 1.50 | 1.71 |
| 2 | 13.1 | 1.29 | 1.44 | 1.64 | 1.79 | 2.04 |
| 3 | 20.4 | 1.52 | 1.74 | 2.01 | 2.23 | 2.55 |

◆年間消費電力量概算

| 庫内温度 | の仕様 | | | 概算負荷 | 稼働率 | 年間稼働時間 | | | 年間消費電力量 | CO2排出係数 | CO2排出量 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 能力 (A) | 消費電力 (B) | COP (A)/(B) | (C) | (D)−(C)/(A) | 時間 (E) | 日数 (F) | 稼働時間 (G)=(D)×(E)×(F) | kWh (G)×(B) | 関西電力 (H) | |
| -18 | 5.66 | 4.85 | 1.17 | 1.902 | 34% | 24 | 365 | 2943.73 | 14,277 | 0.299 | 4,269 |
| -30 | 3.78 | 4.77 | 0.79 | 2.55 | 67% | 24 | 365 | 5909.52 | 28,188 | 0.299 | 8,428 |
| | | | | | | | | 差 | 13,911 | | 4,159 |

**For temperatures ranging from -18° C to -30° C,**

1. The **estimated annual energy consumption** is **13,911 kWh**
   ↳ assuming an electricity cost of 20 JPY/kWh,
   equivalent to **278,220 JPY**

2. The **CO2 emissions** are approximately **4,159 kg-CO2.**

# 3. Future Challenges and Expectations

# Dream for Future

Shizuoka Sangyo University

DENBA+

DENBA Japan

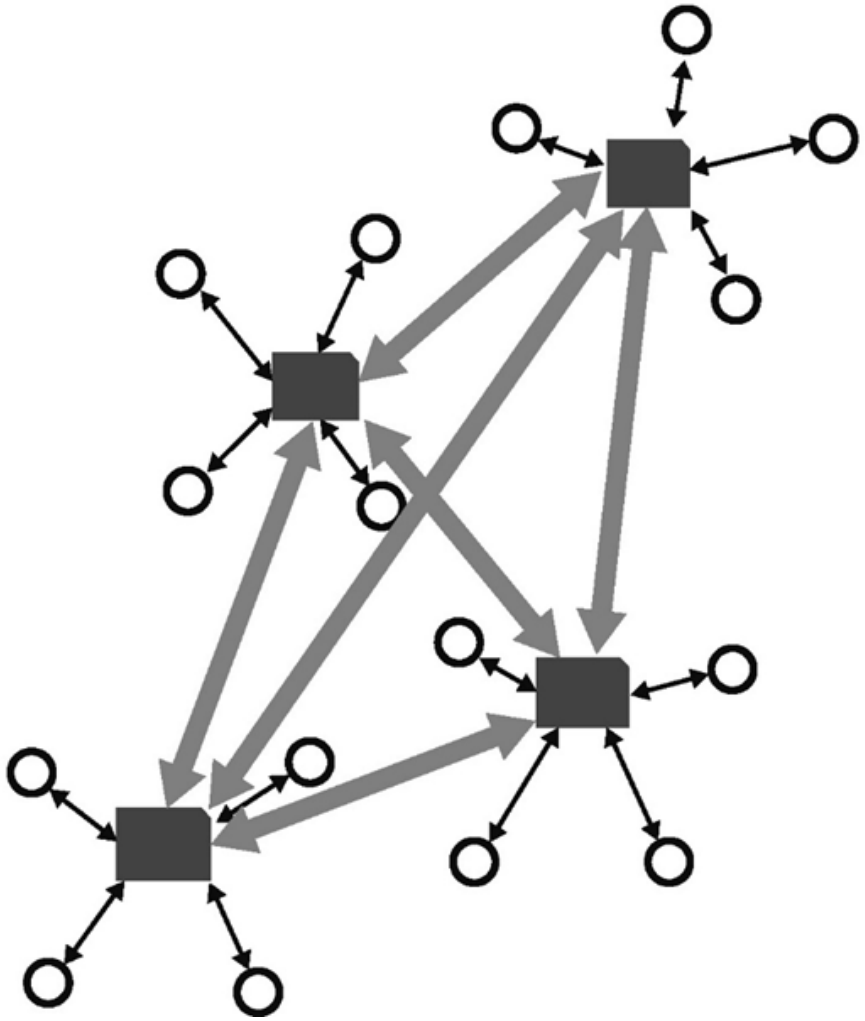
**Technology**

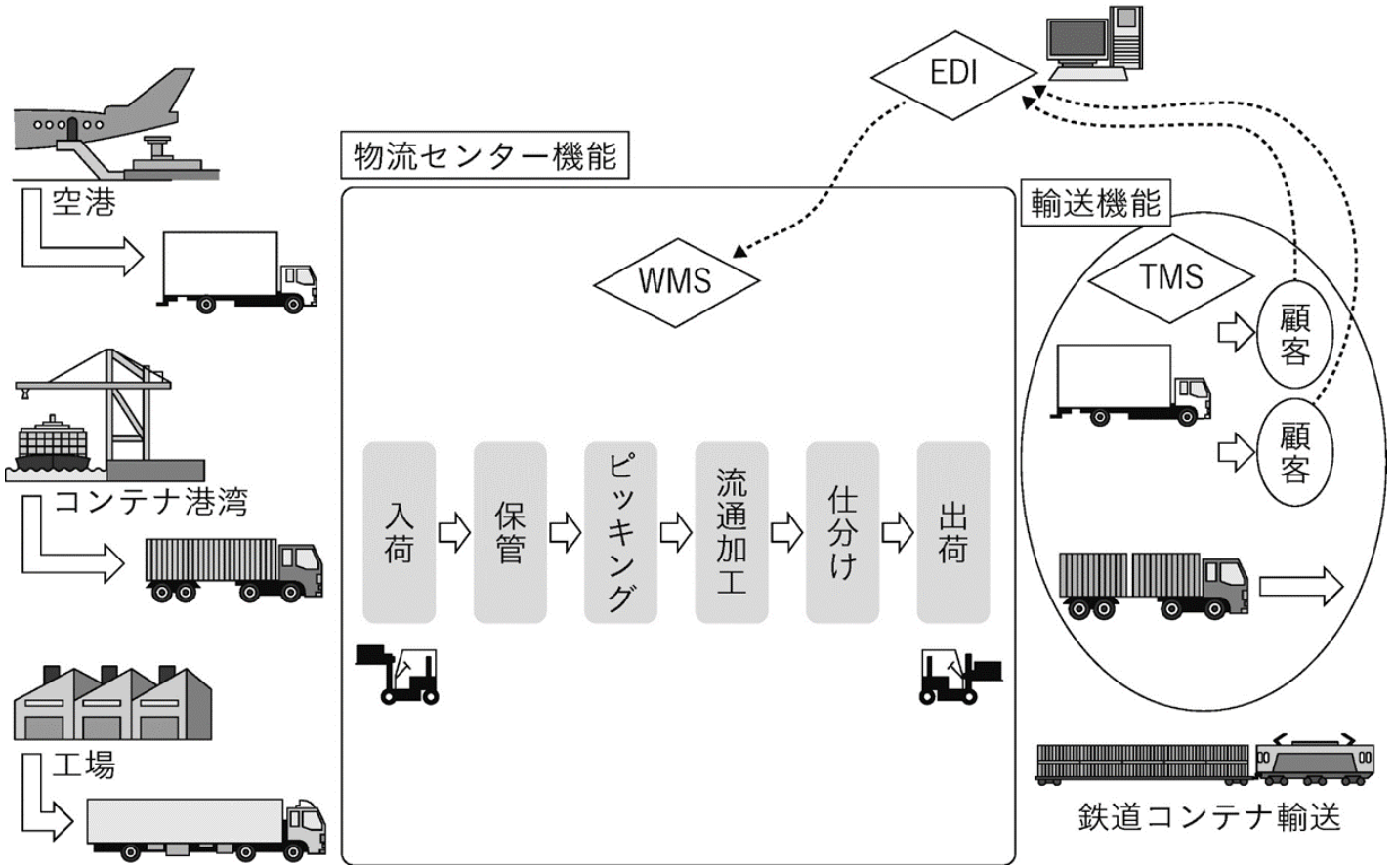
**Logistics**

## Facilitating Carbon Reduction:

***Creating a Global Economic Cycle through Advanced Cold Chain Technology***

# Optimization of Transport Routes



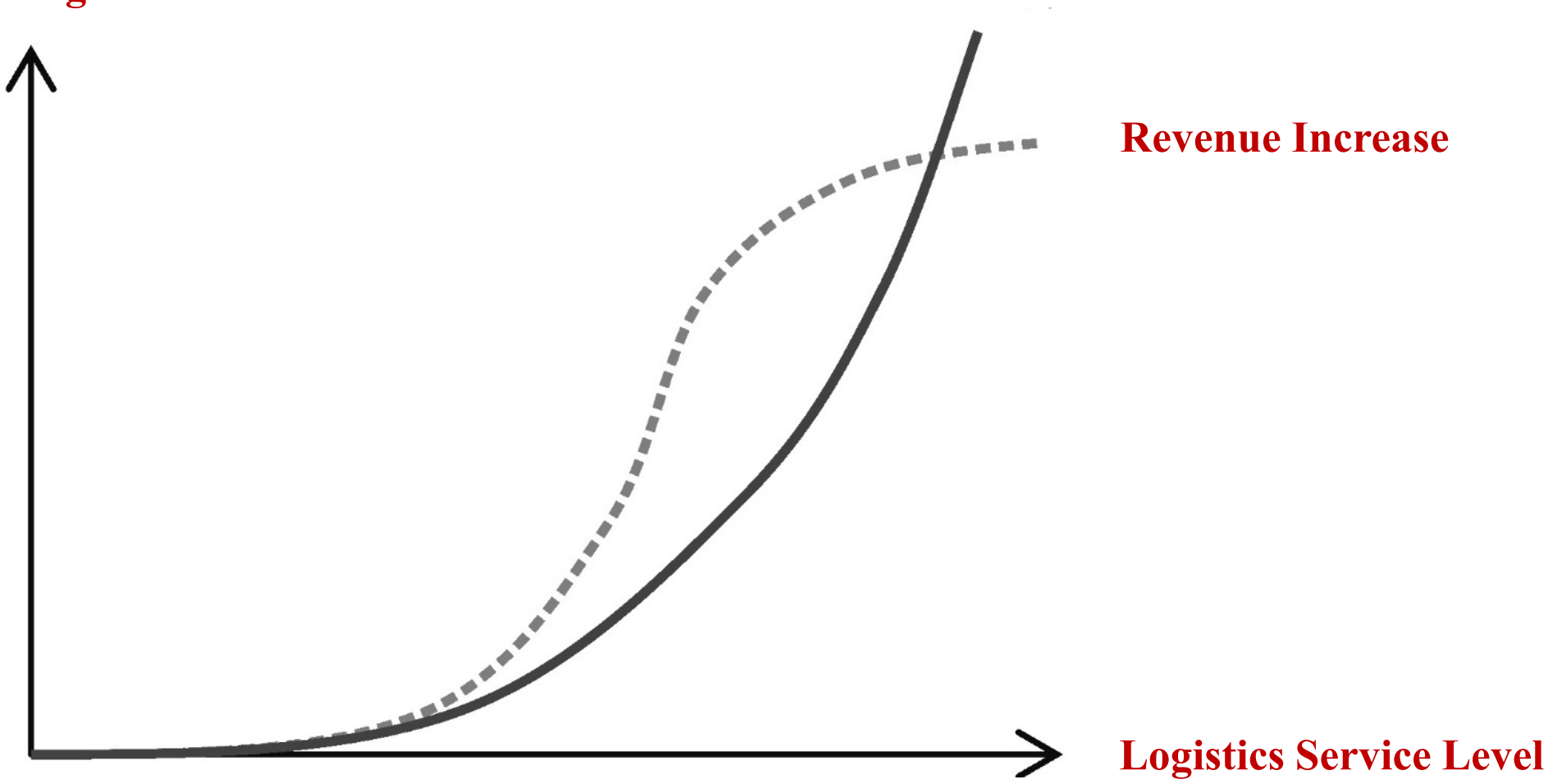



【Source】 Logistics Theory (Chuo Keizai Sha)

# Optimization of Cost : Trade off

Shizuoka Sangyo University

**Cost and Revenue Increase Associated with Logistics Services**



# KGI and KPI for a Sustainable Business Model

Shizuoka Sangyo University

**Management Objective**

**KGI**

$$ROA = \frac{\text{Net Profit}}{\text{Net Asset}} = \frac{\text{Revenue} - \text{Cost} - \text{Tax}}{\text{Current Asset} + \text{Fixed Asset}}$$

**Contribution of Logistics Management**

- Improvement of Logistics Services
- Reduction of Logistics Costs
- Outsourcing of Logistics
- Outsourcing of Logistics

**KPI**

**KGI** : Key Goal Indicator

**KPI** : Key Performance Indicator

# New Concept

Shizuoka Sangyo University

"MaaS" （Mobility as a Service）

Logistics

**Logistics as a Service : LaaS**

# Purpose

Shizuoka Sangyo University

## Logistics technology that balances food freshness preservation and decarbonization

# Target to Well-being

DENBA Japan

http://www.denba-global.com/en/

Shizuoka Sangyo University

https://www.ssu.ac.jp/english/

# Address

Shizuoka Sangyo University
Associate Professor, TAKENORI Iwamoto
Ph.D. in Engineering

4-1-1 Surugadai, Fujieda City, Shizuoka Prefecture

E-mail：t-iwamoto@ssu.ac.jp

**Utilizing information and data to tackle various social issues.**