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Introduction
E-ThermoGenTek Co.,Ltd

E-ThermoGentek Co., Ltd.
E-thermo

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Contents

1．Management Policy

Management Slogan

『To promote the efficient use of energy by promoting thermoelectric power generation.』

Management Philosophy

Based on our extensive experience in the semiconductor business and our unique technology related to thermoelectric power generation, we are working to popularize thermoelectric power generation, which efficiently converts and recovers the vast amount of **low-temperature waste heat (about 300°C or less)** into electrical energy. **By promoting the efficient use of energy, we will achieve the SDGs(Sustainable Development Goals) and contribute to the construction of a sustainable society.**

2. Company profile

Company name	E-ThermoGenTek Co., Ltd.
CEO	Representative Director Michio Okajima
Company Locations	**【Head Office】** 601-8047　102 Kujo CID Building, 13 Higashikujo Shimotonoda-cho, Minami-ku, Kyoto (c/o Asset Witz Co., Ltd.) **【R&D Osaka University base】** 565-0871　2-1 Yamadaoka, Suita City D52, Industry-University Co-Creation Building D, Osaka University **【R&D Katsura base】** 615-8245　Kyoto University Katsura Venture Plaza North Building 202, 1-36 Goryo Ohara, Nishigyo-ku, Kyoto City
Established	February 26,2013
Capital	376 million yen

◎ A third-party share allocation is now in the works.

京都市
ベンチャー企業
目利き委員会
Aランク認定

Certified in
March 2018

J-Startup
KANSAI

Certified in
October 2022

3. History

1） History of E-ThermoGenTek Co., Ltd

- 2013 Founded E-ThermoGenTek
  → E-ThermoGenTek was established as a venture company as part of **Asset Witz's** new business creation efforts to support start-ups in the thermoelectric power generation industry by securing a basic patent covering the thermoelectric power generation module's key technology.
- 2013 Established a development base at Osaka University
- 2016 Increased capital to 28 million yen
  (A third-party allocation of shares was implemented according to the adoption of the NEDO STS project.)
- 2017 Increased capital to 70.72 million yen
- 2018 Certified as an A rank company by the Kyoto City Venture Business Connoisseur Committee
- 2019 Increased capital to 100milliion yen (implemented third-party allotment)
- 2020 Established a development base at Kyoto University Katsura Venture Plaza
- 2020 Increased capital to 151.72 million yen (capital increase through third-party allocation)
- 2021 Increased capital to 201.72 million yen (capital increase through third-party allocation)
- 2021 Increased capital to 326.72 million yen (capital increase through third-party allocation)
- 2022 Selected in the "J-Startup KANSAI" by the Economic Bureau.
- 2023 Capital increased to 376.77 million yen (capital increase through third-party allocation)

3. History

2） Introduction to Asset Witz Co., Ltd.,

- **Asset Witz** has a broad network of influential companies and universities and produces new business proposals and their promotion through open innovation activities that involve collaboration between industry and academia.

  ⇒Universities, cooperating enterprises, and ventures will be developed to encourage commercialization with a business model that develops and supports the development of distinctive core technologies at the stage when the prospects for commercialization are established!

- **Asset Witz** has high skills and experience in new business development and venture management and has a track record of many successes in the past.

- **Asset Witz** has a group of engineers who participate as a team in the practice of research and development, with a large number of veterans of leading companies who have a track record of success in new business development as advisors (Filed more than 15 patents)

4. Management Team

Chairman Mr.Shutaro Nambu

Mr Nambu joined Panasonic Corporation in 1970. Until 1992, for over 22 years, Mr Nambu worked on semiconductor devices' design, development, and commercialization. By creating and commercializing GaAs (gallium arsenide) semiconductor chips for mobile phones in 1990, he made a significant contribution to establishing the mobile phone culture we know today. In 1992, he was promoted to the position of Deputy General Manager at the Panasonic LCD Development Center. Mr Nambu left Panasonic Corporation in 2001 and established Asset Witz Co., Ltd. He has since contributed to the growth of new companies and the advancement of industry-academia collaboration. Mr. Nambu established E-ThermoGenTek Co., Ltd. in 2013. Mr Nambu was chosen to serve as Chairman and Representative Director in 2022.

Representative Director & CEO Mr. Michio Okajima

Mr Okajima joined Panasonic Corporation in 1984 and worked in the R&D of thin displays, electronic devices, and EL materials in the Advanced Technology Research Laboratories until 2001, followed by development planning at the Device Development Center. Beginning in 2005, Mr Okajima oversaw development planning in the semiconductor division's package development department after spending time in the corporate planning group at the corporate headquarters. In 2014, Mr Okajima left Panasonic Corporation and engaged in the R&D of thermoelectric power generation modules and related programs as an Asset Witz Co., Ltd advisor. In 2015, Mr Okajima joined E-ThermoGenTek Co., Ltd. and became the COO of E-ThermoGenTek in the same year.

Director、CFO Yuko Hayashi

Ms Hayashi began working for Asset Witz Co., Ltd. in 2002 and has since been involved in accounting operations. Ms Hayashi has extensive experience in the field of accounting, has contributed to many national R&D initiatives, including NEDO, and enjoys a stellar reputation. Since E-ThermoGenTek Co., Ltd.'s founding, Ms Hayashi has been in charge of the accounting department. She was made CFO of the company in 2015.

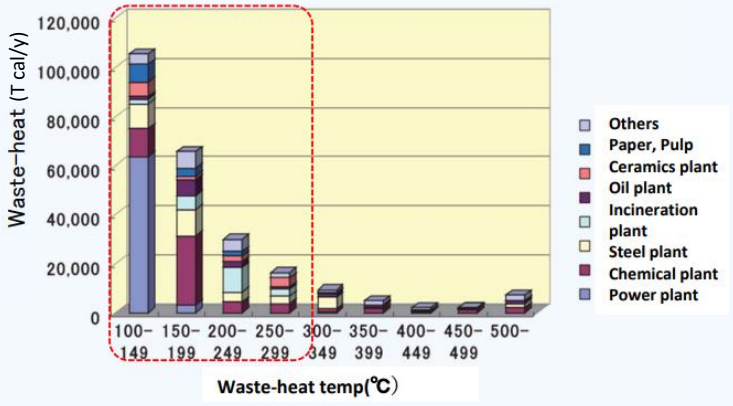
Statutory auditor Keiichi Ohata

Mr Ohata joined NEC Corporation in 1972 and was engaged in the research and development of low-noise GaAsFETs, microwave devices, and millimeter-wave modules for almost 35years until 2007 and has advanced expertise and extensive experience in semiconductor device processes, their application modules, and reliability analysis. Mr Ohata retired from NEC Corporation in 2007 and engaged in the research and development of thermoelectric power generation modules and related programs as an advisor to Asset Witz Co., Ltd. In 2013, Mr Ohata co-founded E-ThermoGenTek Co., Ltd. and had been in charge of intellectual property since 2019. In 2022, Mr Ohata became the statutory auditor of E-ThermoGenTek Co., Ltd.

5. Business Content

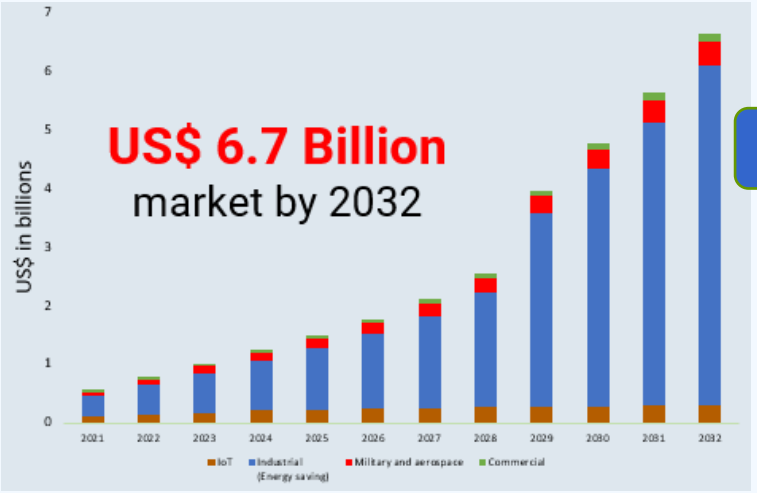
1) Background

1. **Exhaust(waste) heat, which is released into the environment in significant volumes, consumes more than 60% of the primary energy utilized in the world! ! !**
   - → 75% of the exhaust heat is low-temperature exhaust heat or heat produced below 300 °C. (High-temperature exhaust heat is commercialized via steam recovery technology.)
   - → **Compact and easy-to-use thermoelectric power generation that converts waste heat directly into electricity** is gaining popularity as a way to advance the SDGs
   - → Carbon neutrality, which contribute to SDGs.



Status of unused low-temp exhaust heat
(Amount of waste heat by industry and temperature)

Source) Research and Development Strategy Center, Science and Technology Agency, Science and Technology Future Strategy Workshop Report CRDS-FY2012-WR-03 "Development of basic technology for innovation in medium and low temperature heat supply and demand" 25p



Market forecast for TEG modules

Source）Dr. P.Harrop,R.Das "Thermoelectric Energy Harvesting 2022-2042", IDTechEx (2021)

Development of a new thermoelectric power generation technology that recovers vast amount of low temperature waste heat and achieves a **practical cost-performance ratio and reliability** for the First time! !

Various low temperature heat sources


CHEMICAL PLANT


POWER PLANT


INCINERATOR PLANT

LNG PLANT


BOILER


INFRASTRUCTURE


AUTOMOBILE


DATA CENTER


SOLAR POWER


COMPRESSOR/MOTOR


SHIPS


FUEL CELLS

2) Unique Technology

Practical application of flexible thermoelectric power generation module "Flexiina®"! （First in the world！）

Novelty

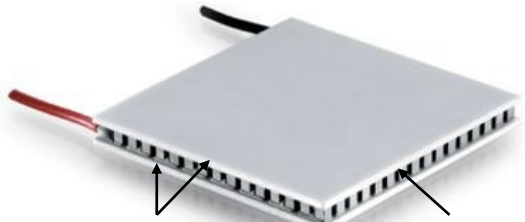
Module structure （Basic Patent；Patent no.5228160）

- High-speed, high-density assembly of existing BiTe thermoelectric components on ultra-thin flexible substrates using mature semiconductor technology ⇒**Cost reduction**
- High energy recovery efficiency is made possible by flexible module structures that may be flexibly curved and attached to cylinder-shaped heat sources ⇒**Elevated performance**

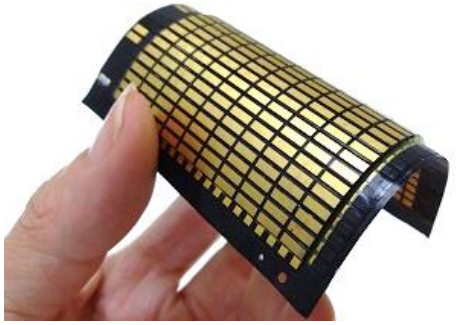
⇒ **Thermoelectric generation with a realistic cost-to-performance ratio has been realized for the first time!!!**

Received inquiries from over 300 companies!!

Conventional thermoelectric power generation module



＜Thick and Rigid＞

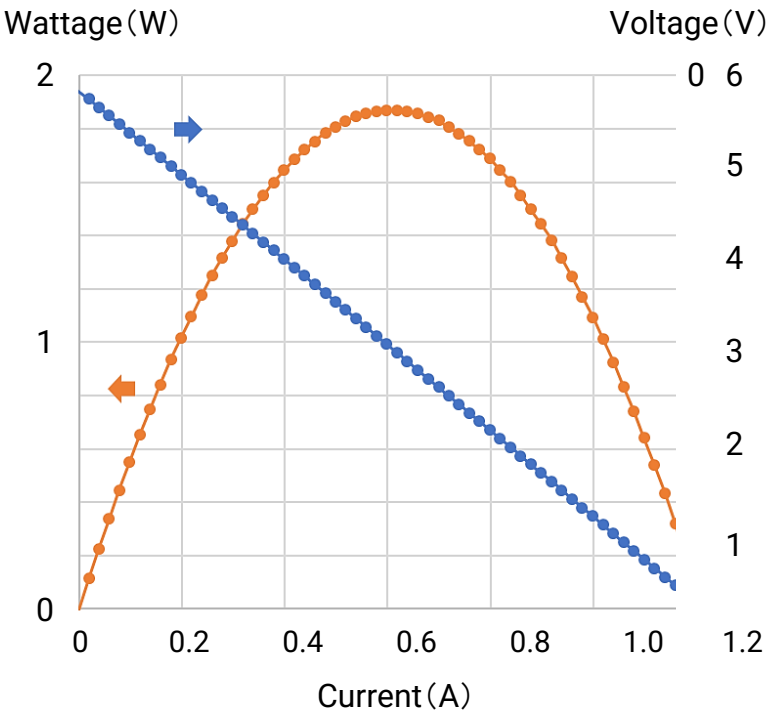


Flexible thermoelectric power generation module“Flexiina®” standard sample

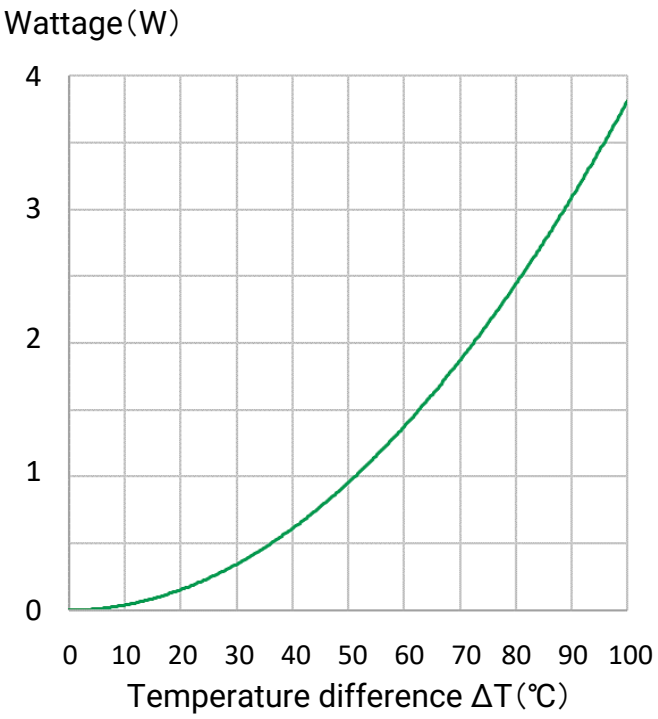
3) Comparative advantage of “Flexiina®”

	「Flexiina®」	Traditional TEG module	Other Flexible TEG module
Thermo electric material	BiTe based chip	BiTe based chip	paste type thermoelectric material
Printed circuit board (PCB)	Flexible film	Ceramic PCB	Flexible film
Manufacturability	○ (Ultra-thin, flexible, adherable)	× (Thick, rigid)	○ (Flexible and adherable)
System composition	○(Simple)	△ (Complex)	○(Simple)
Power generation efficiency	○(1)	△(1/2)	× (1/10～1/20)
Reliability	○	○	×
Cost performance ratio	○(1)	△(1/3)	× (1/10～1/20)

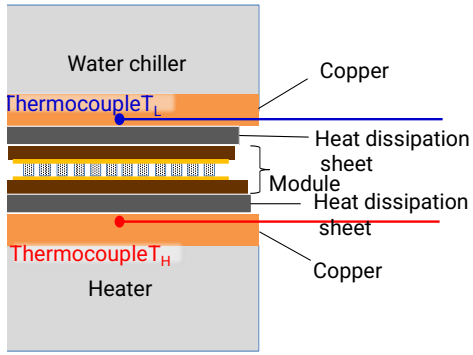
Typical characteristics of the Flexiina ® standard sample (5cm square)



1) Typical output characteristics（at ΔT=70℃）



2) Output for temperature difference ΔT（typ.）



T_H : surface temperature of heater plate

T_L : surface temperature of cooler

$\Delta T = T_H - T_L$

Setup during measurement of 1)、2)

〔Seebeck coefficient (p_{avg}) of the thermo-electric element used: 158 μ V/K]

4) Unique thermoelectric generation element technology with "Flexiina®" for various low temperature heat sources

IoT oriented independent power supply system

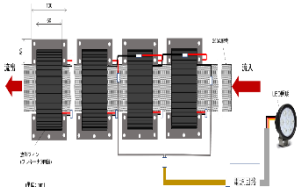
Wrap-to small bore heat source (S1-P Series)

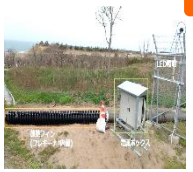
Sample under sale

1. Compact and high power
2. Easy attachment to pipe heat sources
3. Significantly reduces auxiliary costs such as cable installation and battery replacement.

Wrap-to large diameter heat source (Exhaust water/liquid)-(S1-P3)

PoC





1. Easily attached to steam/heat/drainage pipework
2. No need to install power cables
3. operates with natural air-cooling.

collaboration: ENEOS Holdings Ltd.

Mount-to Flat heat source (S1-F Series)

Sample under sale

1. Easy installation on flat heat sources
2. Output possible with small temperature differences (ΔT=15℃or more)
3. No battery replacement required

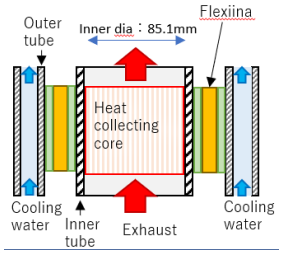
For remote mountainous areas: Air-cooled type for warm water and drainage piping (S1-PA)

1. Improved corrosion resistance.
2. Equipped with Battery Management System (BMS) For high maintainability

Core Energy saving Independent Power supply System

Heat Collecting Core type (Exhaust Gas)

PoC



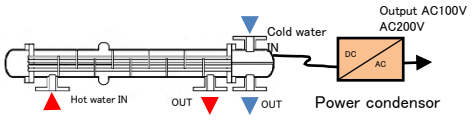
1.Highly efficient heat recovery from various thermal exhaust gases by a unique heat collecting core!

2. Highly efficient power generation by water-cooled system!

Collaboration: Ryonetsu Kogyo Co.

Power Generation Tubes for heat exchangers (Residual steam)

PoC



Heat exchanger

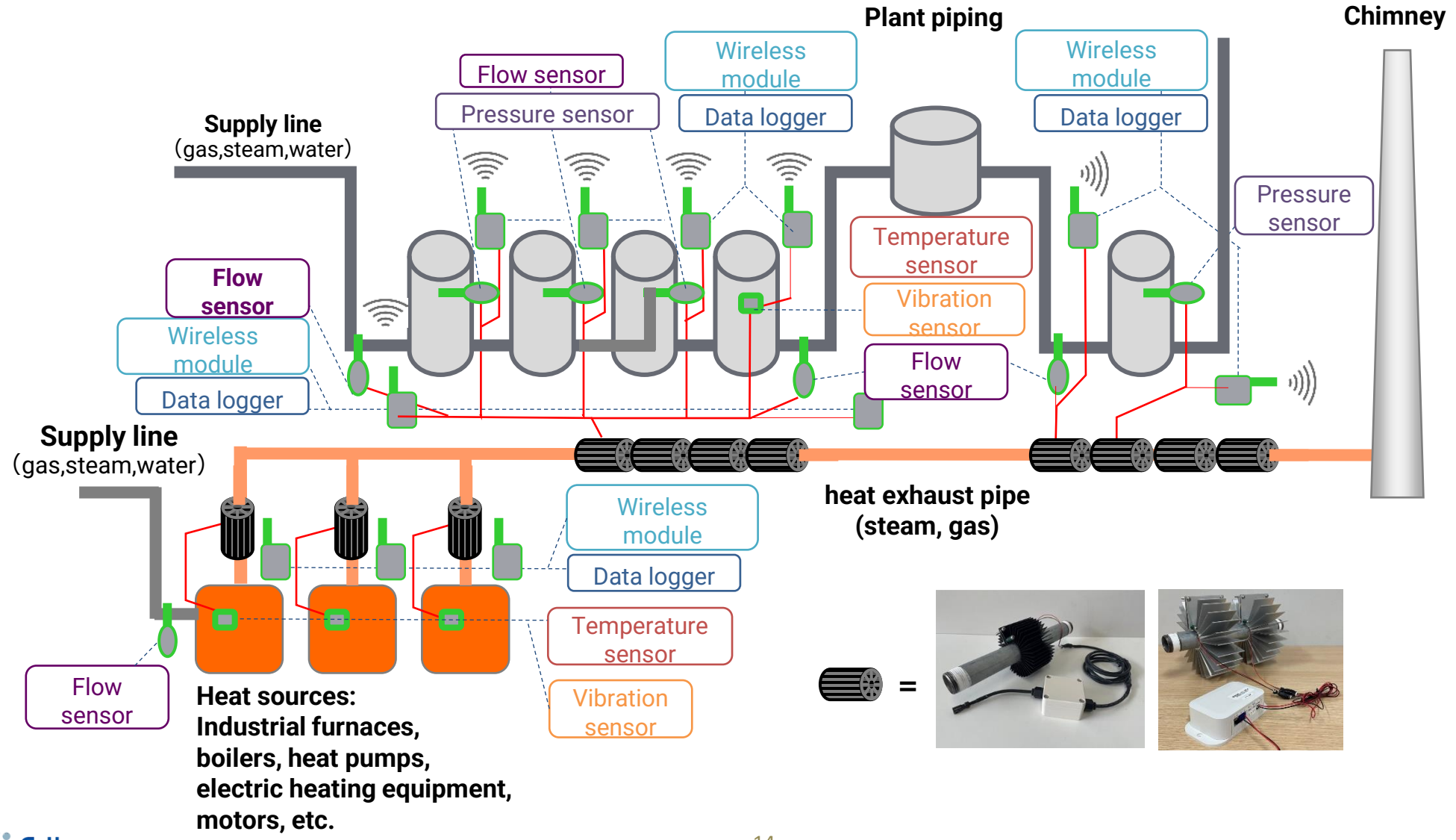
Heat generator tube

1. No moving parts such as generators reducing maintenance costs.
2. High reliability due to seamless pipes.

Collaboration: Kawasaki Heavy Industries, Ltd.,

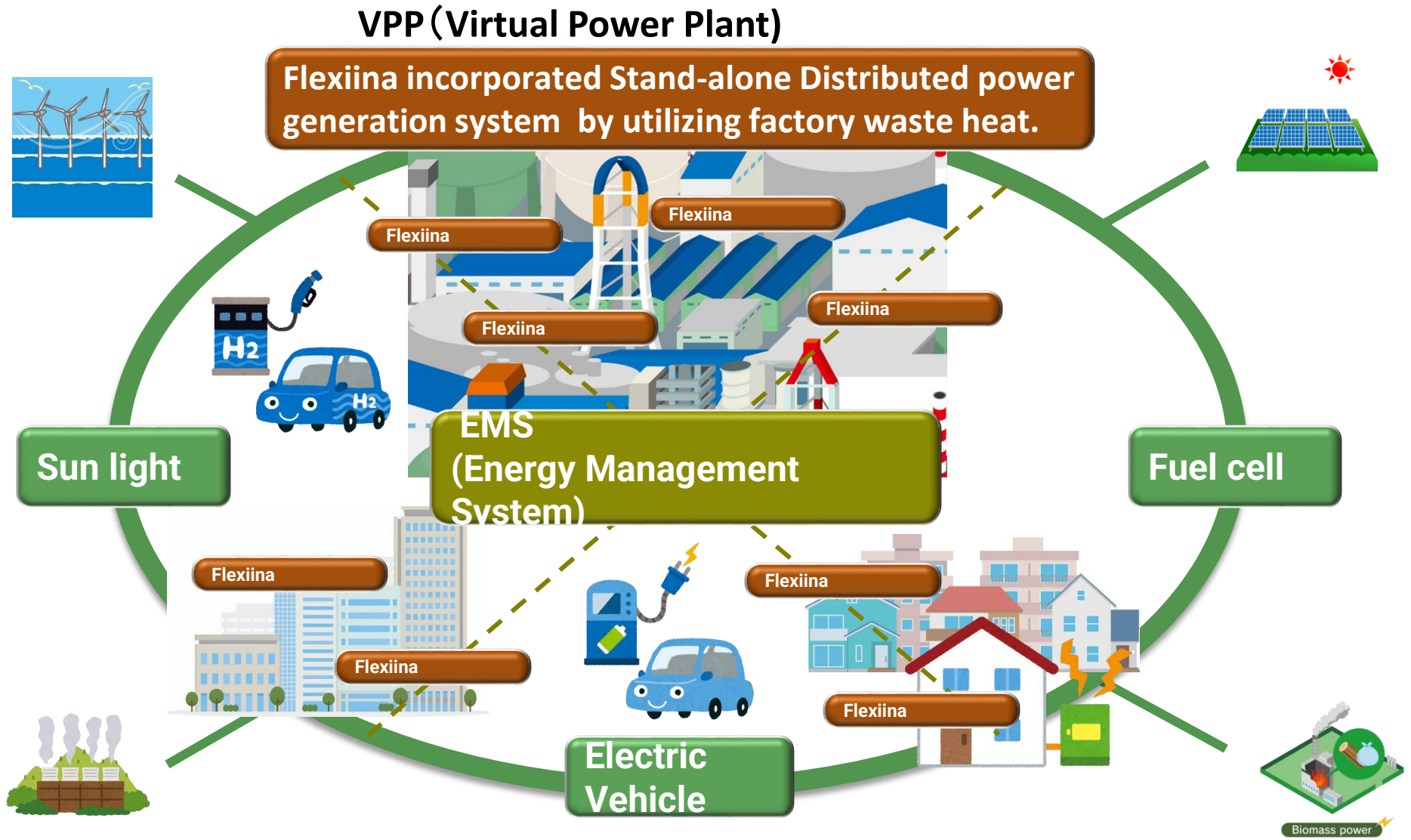
「Flexiina®」driven Stand-alone power supply「S1series」for IoT (Factory installation image)

○ **Installation example of Sensor and stand-alone power supplies for plants**



5) Future vision

Energy management system with the concept of ‘Local production for local consumption’ using residual heat



6. Accomplishments

1） History of Grants

FY 2023: Ministry of Economy, Trade and Industry (METI) - Growth-Oriented Small and Medium Enterprises Research and Development Support Program (Go-Tech Project)

FY 2023: New Energy and Industrial Technology Development Organization (NEDO) - Research and Development and Social Implementation Acceleration Program for Energy-saving Technologies toward Achieving a Decarbonized Society (Practical Application Phase)

FY 2022: NEDO - Technology Research and Development Program for Exploration and Commercialization of New Energy Sources (Phase B)

FY 2022: NEDO - Research and Development Support Program for Research-oriented Startups (Business Course 1)

FY 2021: METI - Third Supplementary Budget for Fiscal Year 2020 Business Reconstruction Subsidies

FY 2020: NEDO - Strategic Energy-saving Technology Innovation Program (Practical Application Phase)

FY 2020: NEDO - Support Program for Innovation in New Energy Technologies by Venture Companies (Phase C)

FY 2018: ASTEM - Kyoto City Future Creation Enterprise Growth Project "New/Improved Research and Development Subsidy Project"

6. Accomplishments

FY 2017: NEDO - Support Program for Innovation in New Energy Technologies by Venture Companies (Phase B, C)
FY 2016: NEDO - Business Support for Commercialization of Research and Development-oriented Ventures in the Seed Stage (STS Project)
FY 2012: Kyoto Industry 21 - Collaborative Innovation Research and Development Program <Company Collaboration Type> - Verification of Commercialization Potential
FY 2012: Ikeda Bank - Consortium Research and Development Grants
FY 2012: METI - Subsidies for Trial Production and Development Support for Manufacturing Small and Medium-sized Enterprises and Small Businesses

Prior to FY 2010: 2 cases from NEDO

2) Basic patents related to this thermoelectric power generation technology.

Title of invention [Patent No.]	Patent Holder	Contents (summary)
Thermoelectric conversion module, its manufacturing method, and thermoelectric power generation system [Patent No. 5228160]	E-ThermoGenTek Co.,Ltd	The thermoelectric conversion module under research and development in this study involves high-density integration of tiny bulk thermoelectric chip elements on a resin thin film substrate, imparting flexibility by gradually bending the substrate. The basic patent for this technology has already been granted, identifying the fundamental structure of this thermoelectric power generation module.