Environmental Product Declaration

In accordance with ISO 14025 and EN 15804:2012+A2:2019 for:

Prestressed Concrete Steel Wire Strand (PC Strand)

From

The Siam Industrial Wire Co., Ltd.

Programme
The International EPD® System, www.environdec.com

Programme operator
EPD International AB

EPD registration number
S-P-05640

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2027-03-16

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

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GENERAL INFORMATION

Programme information

Programme	**The International EPD® System**	
Address:	**EPD International AB** Box 210 60, SE-100 31 Stockholm, Sweden	**Website** www.environdec.com **Email** info@environdec.com

CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product category rules (PCR): PCR 2019:14 Construction Product, Version 1.11 2021-02-05 (valid until 2024-12-20)
PCR review was conducted by: The Technical Committee of the International EPD® System. **Review chair:** Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☑ External ☐ Internal covering ☐ EPD process certification ☑ EPD verification
Third party verifier: Claudia Peña Urrutia, cpena@addere.cl **Approved by:** The International EPD® System Technical Committee, supported by the Secretariat
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☑ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025.

COMPANY INFORMATION

Description of the organisation

The Siam Industrial Wire Company Limited or SIW was officially established in Saraburi Province on 6 October 1994 as a spinoff of the wire business of the Siam Cement Group. Until 1996, the company relocated to Rayong province. In 2002, Natsteel of Singapore became the major shareholder of SIW in partnership with the Siam Cement Group. SIW became a part of the Tata Steel Global Wires Business, which was established in 2008 to create synergies amongst all the wires business units around the world which are part of the Tata Steel Group. In 2012, SIW diversified into a new galvanized wire business through the joint venture with Nichia Steel Works of Japan to establish TSN Wires. In 2021, T S Global Holdings Pte. Ltd. became the major shareholder of SIW. Over the course of more than twenty-five remarkable years, SIW's annual production capacity has risen to over 250,000 metric tonnes, making them the largest wire manufacturer in Southeast Asia. SIW have had great fortune to be vital partners of many construction masterpieces across the globe. The materials they produces are used worldwide for the construction of bridges, stadiums, high rise buildings, airports, LNG facilities and many more. Everything that SIW do conforms to stringent global standards and are accredited by countless respected international bodies. SIW's global supply chain is designed to minimize pollution and harm to the environment, and SIW have a very strong emphasis on the relationship with its business partners, employees, and the community.

Whether it's with the environment or with communities, SIW puts a very strong emphasis on building lasting relationships. From early on, SIW had recognized the importance of sustainability in everything they touch. At the communities where SIW work in, Siam Industrial Wire invest to improve and sustain the livelihood of locals through community and social development. The SIW employees volunteer in educating the communities on safety, the environment, and the three R's (reduce, reuse, and recycle). SIW's closely controlled global supply chain is optimized every step of the way to minimize pollution and environmental harm.

Product-related or management system-related certifications

This can be seen from the many international certifications obtained such as

- ISO 9001 for Quality Management System
- ISO 14001 for Environmental Management System
- ISO 50001 for Energy Management System
- ISO 45001 for Occupational Health and Safety Management System
- TIS 18001 for Occupational Health and Safety Management System
- ISO 17025 for Quality Management System of Accredited Laboratory
- ISO 17025(NATA) for Quality Management System of Accredited Laboratory
- CSR:DIW (Corporate Social Responsibility: Department of Industrial Works)
- Green Industry Level 4 (Green Culture: Department of Industrial Works)

Details of SIW's commitment to sustainable development can be found in the company's sustainability report.

Name and location of production site

The Siam Industrial Wire, 160 Moo 11 T. Nonglalok, Bankhai, Rayong 21120, Thailand

PRODUCT INFORMATION

Product name

PC Strand

UN CPC code

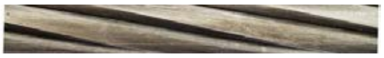
41267 – Wire of alloy steel

Product description

PC Strand is made of 7 cold-drawn high carbon wire rods. There are six outer wires and one single wire which is slightly larger in diameter. The wires are spun together in the same direction and with the same laying length which is subjected to final thermo-mechanical treatment (annealing). The final output of the process is an unadjustable strand in the master coil of 20 – 27 net tonnes which is then wound into smaller diameter coils. The detailed specifications of each PC Strand such as dimensions, and mechanical properties vary depending on the product types and range. SIW's PC Strand is divided into 3 common types. Any different types of PC Strand are generally considered insignificant compared to the overall results. The difference is only in the mechanical part, while the total energy use is not much different. Hence, the environmental performance was grouped.

NOTE The common types of strands are as follows:
a) 7-wire strand: a straight core wire around which are spun six in one layer;
b) 7-wire compacted strand; 7-wire strand that has been drawn through a die, or compressed by other means, before the final thermos-mechanical treatment;
c) 7-wire indented strand: strand produced from indented wires. The central wire of the 7-wire indented strand may be plain with no indentations.

7-wire strand



7-wire compacted strand

7-wire indented strand

Product identification

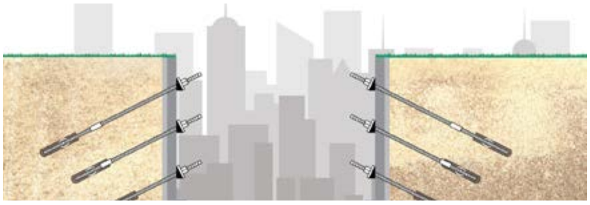
SIW PC strands have been granted the international standard, TIS 420 – 1997, AS/NZS 4672 – 2007, ASTM A416 – 2012, ASTM A416 – 2017, BS 5896 – 2012, prEN 10138 – 2006, FprEN 10138 – 2009, JIS G 3536 – 2014, LNEC E 453 – 2011, XP A35 - 045 - 3 – 2017, MS 1138 - 4 - 2007, TSE 5680 – 1988, IS 14268 – 2017, UNE 36094 – 1997, SFS 1265 - 3 -2014, SS 212553 – 2013, NEN 3868 – 2001, NBN I 10-003 – 1986, UNI 7676 – 2016 and Nr IBDiM-KOT – 2019. SIW also produces special-grade products according to customer's specification.

Major application

Pre-stressed congrete Girders

Bonded post-tensioned flooring system

Hollow-core slabs



Ground and Rock anchors

Technical Infomation

All SIW's PC Strands consists of 7 wires stranded with plain, compacted, or indented surfaces. Technical specifications of PC Strands may vary depending on material grade, size of product and standard.

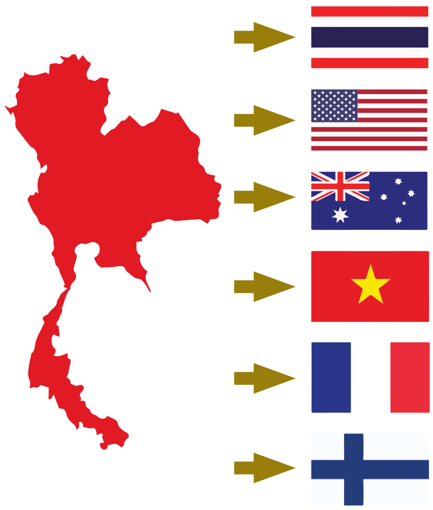
- **Diameter:**
  9.3 - 18 mm.
- **Tensile strength:**
  1700 - 1860 MPa
- **Minimum Breaking Load:**
  88.8 - 436 kN
- **Minimum Yield Load (at 0.10% extension):**
  72.8 - 334 kN
- **Minimum Yield Load (at 0.20% extension):**
  75.4 - 334 kN
- **Minimum Yield Load (at 1.0% extension):**
  92.1 – 251.4 kN
- **Minimum Elongation:**
  3.5%
- **Density:**
  7.85 g/cm3

All products are manufactured from various combinations of different recycled content of high carbon wire rods from qualified suppliers. PC Strand is delivered in coils packaging. The coil is secured onto wooden pallets with eye-to-side (eye horizontal), or eye-to-sky (eye skyward) settings, or without pallets depending on the customer's requirement. The standard width of the coil is 760 mm with a weight of about 3,000 kg. The inner diameter of the coil is 750 mm while the outer diameter is 1,200 mm and the inner diameter of the coil is 900 mm while the outer diameter is 1,350 mm. All SIW's PC Strands are constantly monitored by relevant standards authorities. The mechanical testing laboratory is demonstrated the technical competence to operate in accordance with ISO/IEC 17025. The facility is accredited for tests shown on the scope of accreditation issue by NATA (https://nata.com.au/accredited-organisation/mechanical-testing-laboratory-14508-14548/).

Geographical Scope

Manufactured in Thailand, supplied to Global (the biggest customers are Thailand, USA, Australia, Vietnam, France, and Finland)

Shipped to



LCA INFORMATION

Declared Unit

1 tonne of PC Strand

Reference service life

Not applicable

Time representativeness

Specific data for the manufacturing collected from 2020-01-01 to 2020-12-31. The 10-year age requirement for generic data has been met.

Database(s) and LCA software used

Generic data for for module A1-A2 and Module A4, C1-C4, D use Ecoinvent 3.6 database. Manufacturer-specific data used for module A3. All data modelled by using SimaPro Developer software version 9.2.0.2. No datasets older than 10 years were used.

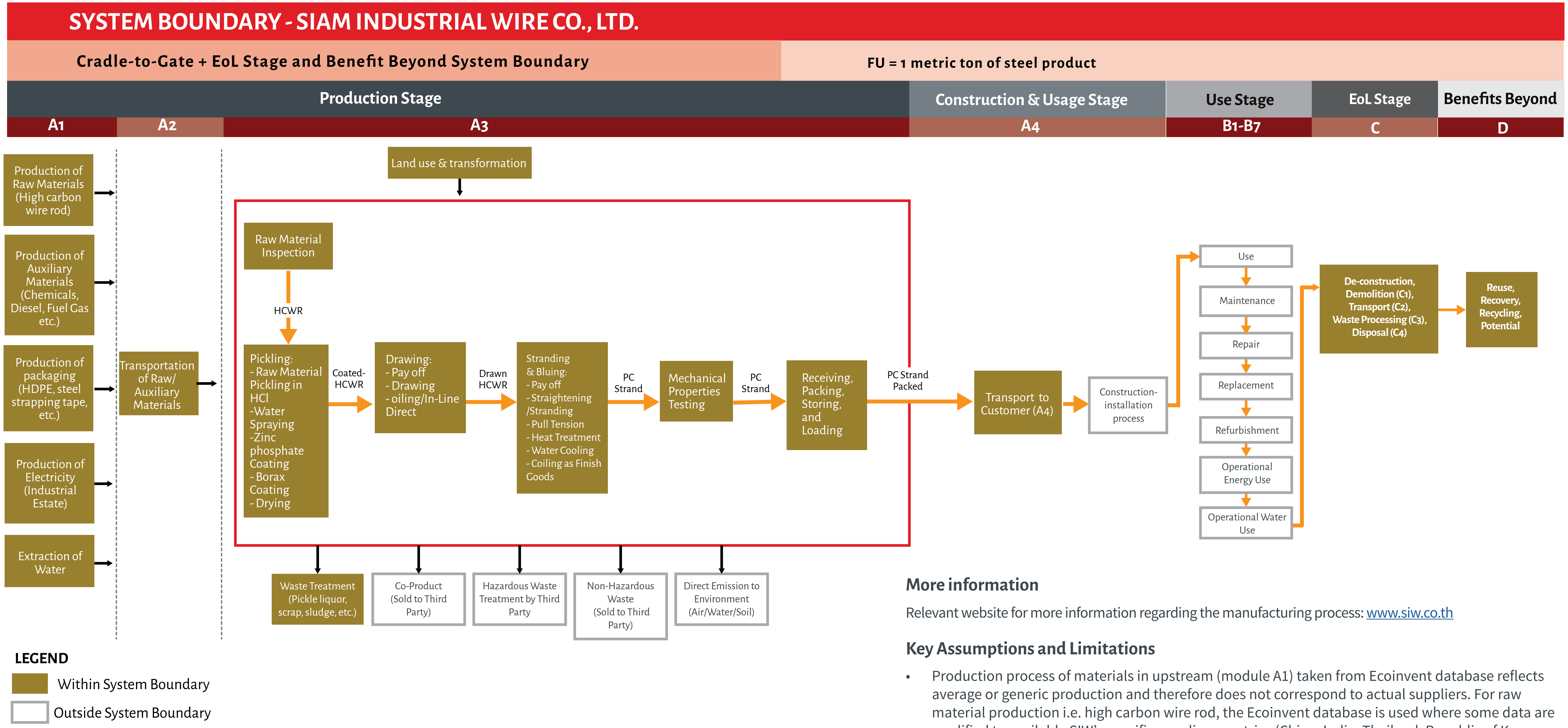
Description of system boundaries

The system boundary was chosen based on the goal and scope of the study and in accordance with EN 15804:2012+A2:2019, i.e. "cradle-to-gate" with options (A1–A3 and additional module A4 on transport), plus modules C1-C4 and module D. Modules A5 and B1-B7 have not been included due to the inability to predict how the material will be used in the construction process and use stage. On the other side, these modules are not yet possible as there is no c-PCR available for steel products at the time of publishing. The processes below are included in the product system to be studied:

1. **Module A1-A2**
    a. Production of raw materials (High carbon wire rod)
    b. Production of auxiliary materials (e.g., Chemicals, Diesel, etc.)
    c. Production of packaging (e.g., High Density Polyethylene Plastic, Steel strapping tape, etc.)
    d. Production of electricity and fuel gas (i.e. natural gas)
    e. Transportation of raw/auxiliary materials from the supplier to manufacturing plant
    f. Extraction of water (i.e. tap water)
2. **Module A3**
    a. Raw material inspection
    b. Pickling: Raw material pickling in HCl, water spraying, Zinc phosphate coating, Borax coating, drying
    c. Drawing: Pay off, drawing, coiling
    d. Stranding and Bluing: Pay off, stranding, pull tension, heat treatment, water cooling, coiling as finished goods
    e. Mechanical properties testing
    f. Receiving, Packing, Storing and Loading
    g. Hazardous and Non-Hazardous waste generated (pickle liquor, scrap, sludge, etc.)
    h. Co-product and non-hazardous waste sold to the third party
    i. Direct emission to the environment
3. **Module A4, C1-C4, D**
    a. Transport product to customer
    b. Deconstruction & Demolition
    c. Transport to waste processing unit
    d. Waste processing including waste treatment process by a registered third party for hazardous waste
    e. Disposal
    f. Reuse/Recovery/Recycling of the end of life of the products

System diagram

The process begins with the pickling process to remove rust and scales on the surface of the high carbon wire rod by dipping the materials into pickle liquor that is hydrochloric acid (HCl). After that, the wire rod is sprayed with water before being coated with zinc phosphate and then borax to facilitate the drawing process. The coated wire rod is drawn to the required diameter to give mechanical properties suitable for application. The process requires lubricant as a coating to allow the wire surface to slip easily. The stranding machine pulls wires off the spools while maintaining a specified rate of wrapping. After the wires have been stranded, the strand is subjected to high heat while under tension which relieves the residual wire drawing stresses, permanently elongating the strand, increasing the yield strength and reducing relaxation losses. Finally, the strand is put in a water bath to freeze the steel in the permanently elongated state and to rinse any residual drawing lubricant from its surface.



Note: Module A4, C and D are scenarios

More information

Relevant website for more information regarding the manufacturing process: www.siw.co.th

Key Assumptions and Limitations

- Production process of materials in upstream (module A1) taken from Ecoinvent database reflects average or generic production and therefore does not correspond to actual suppliers. For raw material production i.e. high carbon wire rod, the Ecoinvent database is used where some data are modified to available SIW's specific supplier countries (China, India, Thailand, Republic of Korea, and Germany) databases, i.e. for input water, natural gas, electricity, and wastewater. The content of high carbon wire rods also has been modified based on the suppliers. The modification method is by adjusting the % virgin material (pig iron) and % recycled material (iron scraps).
- The emissions and impacts of electricity production are based on the modified Ecoinvent database which only has primary data for GHG information on GULF NLL2 Co., Ltd. However, the emissions resulting from the combined cycle gas-fired power stations (natural gas) are based on the generic data from Ecoinvent, therefore primary data is not available.

- The impact of transportation for raw materials, supporting materials, and products to customers are calculated based on the amount of load, distance, and transportation type by using generic data from Ecoinvent. Due to limited information, there is no adjustment made as the suppliers mostly use another third party to transport the products to SIW.
- There is no direct measurement for emissions that comes from the boiler and wet scrubber. They are calculated based on the sampling every 6 months and then extrapolated to obtain the total emissions for one year in mass units. The air emission from stack (boiler and wet scrubber) is calculated based on the air velocity, cross-sectional area of stack, and the running hour of the stack which is 24 hours for 363 days (2-day shutdown). In the future study, it can be a recommendation for the company to do direct measurement for boiler and wet scrubber.
- The water consumption was counted from the amount of makeup water to compensate the losses due to water evaporation.
- The impact of land use changes are considered immaterial and have not been included because the land use change was done more than 26 years ago.
- Emission to air is only measured on boiler and wet scrubber stack, where the sampling is conducted semi-annually.
- The cooling tower is used in the pickling until the stranding & bluing process. However, the electricity of the cooling tower is only included in the drawing and stranding process (allocated into two processes). The electricity consumption of cooling in the pickling process is included in the drawing and stranding process.

Cut-off rules

In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be 1 % of renewable and non-renewable primary energy usage and 1 % of the total mass input of that unit process. The total of neglected input flows per module, e.g., per module A1-A3, A4, C1-C4 and module D shall be a maximum of 5 % of energy usage and mass. In this study, all data in the product system is included. If there is missing specific data, generic data from the database or literature will be used.

Data Quality

- Time related coverage: specific data were collected from 2020-01-01 to 2020-12-31, and generic data are representative of the year 2020.
- Geographic coverage: specific data were collected from the area under study, i.e., Rayong, Thailand. Electricity production as a key input are sourced from GULF NLL2 Co., Ltd. network, Thailand. Therefore, data that has been adjusted to represent GULF NLL2 Co., Ltd. was used. Another key input is high carbon wire rods that is sourced from China, India, Thailand, Germany, and Republic of Korea. No specific data were available for high carbon wire rods production. Therefore, rest-of-world data with some adjustments to the available China, India, Thailand, Germany, and Republic of Korea Ecoinvent database was used.
- Technological coverage: specific data were collected from current steel making process under study. There is no specific data for module A1-A2 and module A4, C1-C4; therefore generic data from the global average was used with similar technology aspects to describe the process under study.

Data quality for both specific and generic data were sufficient to conduct life cycle assessment in accordance with the defined goal and scope.

Allocation Rules

Economic allocation was applied in accordance with EN 15804:2012+A2:2019. Economic allocation was applied to allocate the total amount of high carbon wire rods used and the scrap produced in the raw material inspection process from each supplier country. Allocation was also applied to allocate the main product and the defective product coming out of the stranding and bluing process and allocate the main product and the scraps coming out of the mechanical properties testing. For the end-of-life of waste generated in the manufacturing process, the disposal scenarios principle is applied for each type of waste. This means that SIW will carry the full environmental impact until the end-of-waste state is reached. Multi-input allocation is relevant for the end of life of waste generated in manufacturing process, disposal scenarios are applied for each type of waste.

In this study, the closed-loop process is applied. When the scrap is used in the manufacture of a new product, there is an allocation (or debit) associated with the scrap input. Meanwhile the recovered steel scrap for recycling is allocated a credit (or benefit) associated with the avoided impacts of the virgin material. If the amount of recovered steel scrap for recycling is less than what the product system requires/steel scrap needed in the manufacture, then the environmental burdens associated with meeting the raw material demand are included in this closed-loop model. If, however, the amount of recovered steel scrap for recycling is larger than what the product system requires/steel scrap needed in the manufacture, then the product system receives a net credit, equivalent to the net amount of virgin material avoided.

The recovered steel scrap that is not looped back to the manufacture (leaving product system that have passed the end-of-waste state), goes to module D, except those which have been allocated as co-product. The end-of-waste state of the steel scrap is reached when the steel scrap is processed in the waste processing (Module C3). The steel scrap is sorted and pressed into blocks and ready to be used for other specific purposes. After the point of end-of-waste, the downstream emissions related to transportation process from recycler to manufacture is attributed to the processing unit that uses the secondary material.

The impacts assigned to the credit or burden that comes from module D are calculated by adding impact connected to secondary steel production from EAF plant (beyond system boundary) and subtracting the impacts resulting from primary steel production at BOS plant. The difference between 100% primary steel production (BOS plant) and 100% secondary steel production (EAF plant) is the result of the module D. The calculation is following worldsteel methodology of steel scrap.

The benefit beyond system boundary (module D) is a credit estimation resulted from the system because in real-life there is a trans-continent boundary of the market of each customers' country Thailand/USA/Australia/Vietnam/France/Finland and producers in Thailand which do not share the recycled material market. The assessed products are exported to 36 countries spread out all over the world In this study, applying the Pareto rules on the distribution of the products, only countries that are within 80% market share were taken into account i.e. Thailand, USA, Australia, Vietnam, France, and Finland. Therefore, the recovery rate for recycling is adjusted to the rate in each country and the steel scrap that is considered as material losses will go to landfills.

LCA Scenarios and Additional Technical Information

- The electricity grid in module A3 was based on Ecoinvent database for Thailand that was modified with the GHG information from GULF NLL2 Co., Ltd, i.e. 1 kWh electricity produced generates 537 g CO_2 eq with combined cycle gas-fired power stations (natural gas). However, the emissions resulting from the combined cycle gas-fired power stations (natural gas) are based on the generic data from Ecoinvent, therefore primary data is not available.
- The high carbon wire rod materials in SIW are sources from 11 suppliers in five countries (China, India, Thailand, Germany, and Republic of Korea). Therefore the Ecoinvent database is used based on specific supplier countries. Each supplier has its own product specification, which in this study were differentiated based on the recycled content in the raw materials they produce. The recycled content average was used for the dataset modification. In the dataset, it only affects the raw material production with electrical arc furnace technology that is implemented for the production of steel products with recycled materials. Furthermore, the recycled content percentage is used to modify the composition of pig iron and recycled iron materials.
- The characterisation factor (CF) for water use is modified to describe the watershed level where the unit process withdraws water, i.e., Nonglalok, Bankhai, Rayong. The CF data is documented by AWARE through a Google Layer Document that provides CF up to watershed level in the region. The CF ranges from 0.1 up to 100 with the annual average is 17.8. Therefore, the CF for water is modified to 17.8 m3/m3 from average Thailand 7.0 m3/m3.

- Transportation using trucks in Thailand and customer countries adjusted to its EURO level to represent the current condition. In Thailand, Vietnam and USA EURO4 is used. Meanwhile in Australia, France and Finland EURO5 is used as a standard emission.
- Transport distance was calculated by Google Maps from SIW to Thailand's Port (Map Ta Phut Industrial Port, 27.2 km), and Thailand's Port to destination port (Los Angeles Port, USA = 32,211.84 km; Sydney Port, Australia = 10,030.43 km; Haiphong Port, Vietnam = 3,028.02 km; Le Havre Port, France = 18,277.39 km; Helsinki Port, Finland = 21,225.77 km).
- Transportation in overseas customer countries is calculated based on the average truck travelled per day (USA = 276.68 km; Australia = 56.86 km; Vietnam = 111.59 km; France = 88.37 km; Finland = 8.93 km).
- Local transportation to Thailand customers (module A4) is calculated based on a weighted average of specific market data (i.e. 266.27 km). Meanwhile, the transportation to the waste processing and disposal area (Module C) is calculated based on the average truck travelled per day in Thailand (i.e.173.75 km).
- Amount of diesel used for demolition process was modelled using Ecoinvent database (Waste reinforcement steel {RoW}| treatment of waste reinforcement steel, recycling | Cut-off, U) for global data, i.e., 0.626 MJ diesel/kg steel.
- Amount of diesel and electricity consumption for waste processing was modelled using Ecoinvent database for global data on sorting and pressing iron scrap, i.e., 0.1 MJ diesel/kg steel and 0.01 kWh/kg steel.
- Electricity was modelled using Ecoinvent database for Thailand, USA, Australia, Vietnam, France, and Finland.
- Average recycling rate for steel is 20.01% in Thailand according to International Trade Centre (2020). Meanwhile, in USA it is around 14.11% according to Institute of Scrap Recycling Industries (2020), in Australia it is around 17.11% according to Bureau International Recycling (2020), in Vietnam it is around 5.21% according to OEC (2019), in France it is around 3.06% according to Bureau International Recycling (2020), and in Finland it is around 3.93% according to International Trade Centre (2020). Around 36.56% of the steel scrap was considered as material losses that will go to landfill.
- SIW uses external scrap in its steel production. Net scrap was calculated by excluding the amount of internal scrap (home scrap). The potential environmental benefit calculated for the end-of-life stage (Module D) was based on the net amount of scrap left in the system in accordance with "value of scrap" worldsteel methodology.

Modules declared, geographical scope, share of specific data (in GWP-GHG indicator) and data variation

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	CN, IN, TH, KR, DE	CN, IN, TH, KR, DE	TH	GLO	-	-	-	-	-	-	-	-	GLO	GLO	GLO	GLO	GLO
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	Not Relevant			-	-	-	-	-	-	-	-	-	-	-	-	-	-

CONTENT INFORMATION

PC Strand manufactured by SIW is made of low alloy steels with pig iron and approximately 43 % scrap-based material. SIW followed the chemical range of PC Strand as per spec, therefore, our typical chemical composition can be seen below.

Product content	Weight %
Iron (virgin sources)	Approx. 56.62%
Recycled Material (pre- and post-consumer)	Approx. 43.38 %
Chemical composition, %	**PC Strand**
Iron (Fe)	98 - 99
Carbon (C)	0.60 – 0.90
Sulpur (S)	0.025 or 0.030 or 0.050 max
Phosphorus (P)	0.020 or 0.025 or 0.030 or 0.040 max
Manganese (Mn)	0.50 – 0.90
Silicon (Si)	0.10 – 0.35
Nitrogen (N)	0.007 max
Chromium (Cr)	0.30 max
Copper (Cu)	0.20 or 0.25 max
Nickel (Ni)	0.20 max
Molybdenum (Mo)	0.05 max
Aluminum (Al)	0.01 max

Chemical composition may vary from product standards.

Packaging

All products packing consists of:

- Stretch film
- High Density Polyethylene Plastic
- Sticker
- Rubber pad
- Label
- Steel strapping tape
- Buckle
- Wooden pallet

Based on MSDS, PC Strand manufactured by SIW doesn’t contain any dangerous substances from the candidate list of SVHC for Authorisation.

ENVIRONMENTAL INFORMATION

Potential environmental impact – mandatory indicators according to EN 15804:2012+A2:2019

Results for 1 tonne of PC Strand								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq.	2.21E+03	1.05E+02	5.37E+01	2.27E+01	1.51E+01	1.06E+01	-3.00E+02
GWP-fossil	kg CO_2 eq.	2.21E+03	1.05E+02	5.37E+01	2.27E+01	1.51E+01	1.06E+01	-3.00E+02
GWP-biogenic	kg CO_2 eq.	1.16E+00	7.74E-03	4.09E-03	1.65E-03	1.55E-02	8.43E-04	-9.02E-02
GWP-luluc	kg CO_2 eq.	4.85E-01	1.14E-03	7.79E-04	2.83E-04	7.94E-03	1.44E-04	-6.24E-03
ODP	kg CFC_{11} eq.	1.04E-04	2.25E-05	1.21E-05	5.15E-06	2.23E-06	2.40E-06	-8.69E-06
AP	mol H^+ eq.	1.48E+01	2.46E+00	5.81E-01	1.04E-01	1.18E-01	5.47E-02	-1.36E+00
EP-freshwater	kg P eq.	8.57E-02	1.27E-04	4.21E-05	5.38E-05	6.81E-04	2.64E-05	-1.58E-02
EP-marine	kg N eq.	3.95E+00	5.73E-01	2.60E-01	3.78E-02	4.54E-02	2.06E-02	-2.39E-01
EP-terrestrial	mol N eq.	4.22E+01	6.39E+00	2.86E+00	4.15E-01	4.98E-01	2.27E-01	-2.90E+00
POCP	kg NMVOC eq.	1.39E+01	1.64E+00	7.81E-01	1.08E-01	1.37E-01	5.97E-02	-1.63E+00
ADP-minerals & metals	kg Sb eq.	4.89E-03	1.20E-05	2.40E-05	6.95E-06	1.89E-05	3.36E-06	-5.68E-03
ADP-fossil	MJ, net calorific value	2.36E+04	1.38E+03	7.45E+02	3.21E+02	2.07E+02	1.50E+02	-2.39E+03
WDP	m^3 world eq. deprived	1.28E+02	-8.36E-02	1.44E-01	1.06E-01	8.36E-01	4.97E-02	-5.20E+01
Acronyms	GGWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption							

Potential environmental impact – additional environmental information according to EN 15804:2012+A2:2019

Results for 1 tonne of PC Strand								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
PM	Disease incidence	2.21E-04	3.79E-06	1.56E-05	1.51E-06	2.54E-06	8.98E-07	-2.28E-05
IRP	kBq U235 eq.	2.43E+01	6.03E+00	3.25E+00	1.38E+00	8.58E-01	6.43E-01	-3.36E-01
ETP-fw	CTUe	5.57E+04	5.07E+02	2.52E+02	1.44E+02	8.46E+01	6.81E+01	-1.75E+04
HTP-c	CTUh	1.56E-05	1.47E-08	3.24E-09	1.91E-09	1.29E-09	8.96E-10	-2.03E-06
HTP-nc	CTUh	3.34E-04	5.55E-07	2.61E-07	2.15E-07	8.26E-08	1.01E-07	3.57E-05
SQP	dimensionless	3.77E+03	4.75E+00	2.13E+00	1.54E+00	7.06E+00	1.57E+01	-5.65E+02

Potential environmental impact – environmental information according to EN 15804:2012+A1:2013

The environmental indicators and characterization methods from EN 15804:2012+A1:2013 included in this report are provided solely for method transition purposes. Other life cycle assessment (LCA) rules, such as system boundaries, allocation procedures, and related methodologies, follow EN 15804:2012+A2:2019. Therefore, the results associated with the "A1 indicators" should not be interpreted or claimed as fully compliant with EN 15804:2012+A1:2013.

Results for 1 tonne of PC Strand								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
GWP	kg CO_2 eq.	2.06E+03	1.04E+02	5.31E+01	2.25E+01	1.48E+01	1.05E+01	-2.74E+02
ODP	kg CFC_{11} eq.	1.01E-04	1.78E-05	9.57E-06	4.07E-06	1.83E-06	1.90E-06	-1.10E-05
AP	kg SO_2 eq.	1.17E+01	1.98E+00	4.12E-01	7.79E-02	8.70E-02	4.06E-02	-1.11E+00
EP	kg PO_4^{3-} eq.	1.72E+00	2.03E-01	9.14E-02	1.46E-02	1.81E-02	7.81E-03	-1.46E-01
POCP	kg C_2H_4 eq.	2.10E+00	8.65E-02	4.89E-02	5.31E-03	9.00E-03	3.19E-03	-4.98E-01
ADPE	kg Sb eq.	4.98E-03	1.20E-05	2.40E-05	6.95E-06	1.90E-05	3.36E-06	-5.68E-03
ADPF	MJ	3.15E+04	1.36E+03	7.27E+02	3.17E+02	2.15E+02	1.48E+02	-3.64E+03

No biogenic carbon content in product.

Climate impact (GWP-GHG) – according to PCR

Results for 1 tonne of PC Strand								
Impact Indicator	Unit	Total A1-A3	A4	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	2.12E+03	1.04E+02	5.32E+01	2.25E+01	1.50E+01	1.06E+01	-2.82E+02

Resource use

Results for 1 tonne PC Strand								
Parameter	**Unit**	**Total A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	1.01E+03	1.71E+00	1.13E+00	3.90E-01	6.89E+00	2.13E-01	-2.73E+02
PERM	MJ	0	0	0	0	0	0	0
PERT	MJ	1.01E+03	1.71E+00	1.13E+00	3.90E-01	6.89E+00	2.13E-01	-2.73E+02
PENRE	MJ	2.53E+04	1.40E+03	7.91E+02	3.41E+02	2.23E+02	1.59E+02	-2.49E+03
PENRM	MJ	0	0	0	0	0	0	0
PENRT	MJ	2.53E+04	1.40E+03	7.91E+02	3.41E+02	2.23E+02	1.59E+02	-2.49E+03
SM	kg	4.37E+02	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0
FW	m^3	7.51E+01	2.70E-01	1.98E-01	8.90E-02	5.39E-01	4.17E-02	-2.42E+00
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water							

Waste production

Results for 1 tonne of PC Strand								
Parameter	**Unit**	**Total A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	1.41E-02	0	3.22E-01	0	5.14E-02	0	9.60E+00
Non-hazardous waste disposed	kg	1.04E+02	0	0	0	0	3.66E+02	1.70E+00
Radioactive waste disposed	kg	1.28E-06	0	0	0	0	0	0

Output flows

Results for 1 tonne of PC Strand								
Parameter	**Unit**	**Total A1-A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0	0	0	0	0	0	0
Material for recycling	kg	0	0	0	0	6.34E+02	0	0
Materials for energy recovery	kg	0	0	0	0	0	0	0
Exported energy, electricity	MJ	0	0	0	0	0	0	0
Exported energy, thermal	MJ	0	0	0	0	0	0	0

Information on biogenic carbon content

The biogenic carbon content in PC Strand comes from wooden pallets packaging.

Results for 1 tonne of PC Strand		
Biogenic Carbon Content	**Unit**	**Quantity**
Biogenic carbon content in product	kg C	0
Biogenic carbon content in packaging	kg C	4.39E+00

Note: 1 kg biogenic carbon is equivalent to 44/12 kg CO2.

INTERPRETATION OF RESULTS

- Module A1-A3 contributes significantly to the impact generated by the whole life cycle.

- The production process of high carbon wire rods with 30-40% recycled content from China supplier is the largest contributor to the majority of the potential impacts followed by the production process of high carbon wire rods with 20-25% recycled content from China supplier.

- There is no significant impact on the raw materials and supporting materials transportation process to the potential impact for module A2.

- From the production activities carried out in the SIW area (module A3), the emission to air in the boiler utility appears as a hotspot for acidification potential, eutrophication (marine and terrestrial), photochemical ozone formation, and particulate matter due to emitted emissions such as nitrogen oxides, NMVOC, and particulates, < 2.5 µm.

- Processes on Module A4 are not the largest contributors for the whole life cycle. However, transport products to international customers, i.e. Port of Map Ta Phut, Thailand to USA (module A4) especially by using ships contributes several impact categories such as, global warming potential (fossil), ozone depletion potential, acidification potential, eutrophication potential (marine and terrestrial), abiotic depletion potential (fossil) and ionising radiation. The transport products in customers countries using container truck contributes 2 significant impact categories i.e. ozone depletion potential and ionising radiation.

- Activities carried out on the end-of-life of the steel life cycle (module C1-C4) did not have a significant impact on the overall steel life cycle studied. De-construction and demolition process and transport waste to waste processing using truck in customer country are the only processes from module C which become one of the hotspots to several impact categories such as, ozone depletion potential, eutrophication potential (marine and terrestrial), particulate matter, and ionising radiation.

- Sensitivity analysis was conducted on %virgin and %recycled material of high carbon wire rod with 30-40% recycled content from China supplier. The ± 20% adjustment is made on the input of pig iron and iron scraps. The results show insignificant changes with average overall variation is no more than 20%. Therefore, the environmental performance of pig iron in high carbon wire rod with 30-40% recycled content from China supplier production results are representative.

ADDITIONAL INFORMATION

SIW strives to take part in resolving problems and mitigating impacts from climate. They have established projects to reduce greenhouse gas emissions and enhance energy efficiency on a continuous basis based on our goal to curb greenhouse gas emissions.

SIW also continue to monitor the consumer demand for environmental labelling in the EU, AU and US market. SIW will have a chance to engage with major market on the use of eco labelling through their supply contracts.

SIW have implemented the Quality management system (ISO 9001) in 1994 till present, the Occupational Health & Safety management system (OHSAS 18001 & TIS 18001) in 2003 – 2020, the Environmental management system (ISO 14001) in 2004 till present, the energy management system (ISO 50001) since 2011 till present, the Occupational Health & Safety management system (ISO 45001 & TIS 18001) in 2020 till present and Received Low Carbon Industry (ISO 14064-1) from Department of Industrial Works in 2013, with a focus on maximizing energy efficiency, committing to protect the environment, including prevention of pollution, sustainable use of resources, reducing climate change and protecting biodiversity relevant to the context of the organization that may affect the quality of soil, water and air. If need to disposal the substance must control in criteria. SIW also identify and control occupational hazards & environmental aspects through effective measures in a sustainable manner.

SIW have received CSR - DIW Continuous Award from Department of Industrial Works since 2008, Ministry of Industry. This award has emphasized the organization's determination to proceed continuously corporate social responsibility.

SIW have received Green Industry Award (Level 4) from Department of Industrial Works, Ministry of Industry. The Green Industry is the award for manufacturing firm that commits to do business in an environmental friendly way to achieve sustainability goal by developing and improving continuously on production process and environmental management including corporate social responsibility both internally and externally throughout the supply chain. For Level 4 is mentioned in Green Culture that demonstrates company's accountability on environmental and social concerns as an integral part of the organization's culture.

PC strand products were certified with Carbon Footprint of Product (CFP) in 2020 from Thailand Greenhouse Gas Management Organization (TGO). Carbon Footprint of Products (CFP) is defined as Greenhouse Gas emissions (GHG) of a product through its life cycle stages, including material acquisition, production process, distribution, usage and waste management at its end of life as well as relevant transportation in each stage of the product.

SIW received the LESS Award Letter of Recognition 2021 from the Ministry of Natural Resources and Environment to recognize its contribution to Thailand Greenhouse Gas Management Organization (TGO)'s Low Emission Support Scheme (LESS). In 2021, SIW reduced greenhouse gas emissions by 207,932 kilograms of carbon dioxide equivalents.

DIFFERENCES VS PREVIOUS VERSIONS

VERSION 1.0, 2022-03-16

Original version, complying with PCR 2019:14 Construction Product version 1.11, the General Programme Instructions version 3.01, and EN 15804:2012+A2:2019.

VERSION 1.1, 2023-03-07

Corrected error in the "Waste production" table: the amount of non-hazardous waste disposed of in Total A1-A3 was revised to 1.04E+02 kg.

VERSION 1.2, 2024-09-19

- Update the GWP-biogenic calculation
- Update several Potential Environmental Impact indicators for Modules A1-A3 and A4
- Clarification of EN 15804:2012+A1:2013
- Editorial revision

CONTACT INFORMATION

OWNER OF THE EPD

The Siam Industrial Wire Co., Ltd.

Rasa Tower 1, 14th Floor, 555 Phaholyothin Road,
Chatuchak, Bangkok 10900, Thailand

Telephone
662-9370060-67

Faximile
662-9370068-69

Email
siw@siw.co.th

Website
www.siw.co.th

Contact person:
Pinyo Sunopak (Mr.)
pinyo_s@siw.co.th

LCA PRACTITIONER

PT Life Cycle Indonesia

Kencana Tower Lvl. Mezzanine, Business Park Kebon
Jeruk, Jl. Meruya Ilir No. 88,
Jakarta Barat – 11620, Indonesia

Telephone
+62-21-3042-0634

Email
admin@lifecycleindonesia.com

PROGRAMME OPERATOR

EPD International AB

Box 210 60, SE-100 31
Stockholm, Sweden

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Environmental Product Declaration

The Siam Industrial Wire Co., Ltd.

Head Office

Rasa Tower 1, 14th Floor, 555 Phaholyothin Road,
Chatuchak, Bangkok 10900, Thailand

Telephone	662-9370060-67
Fax.	662-9370068-69
Website	www.siw.co.th