Sustainability in the supply chain of Enel Green Power North America

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MIT MANAGEMENT | Sustainability Initiative

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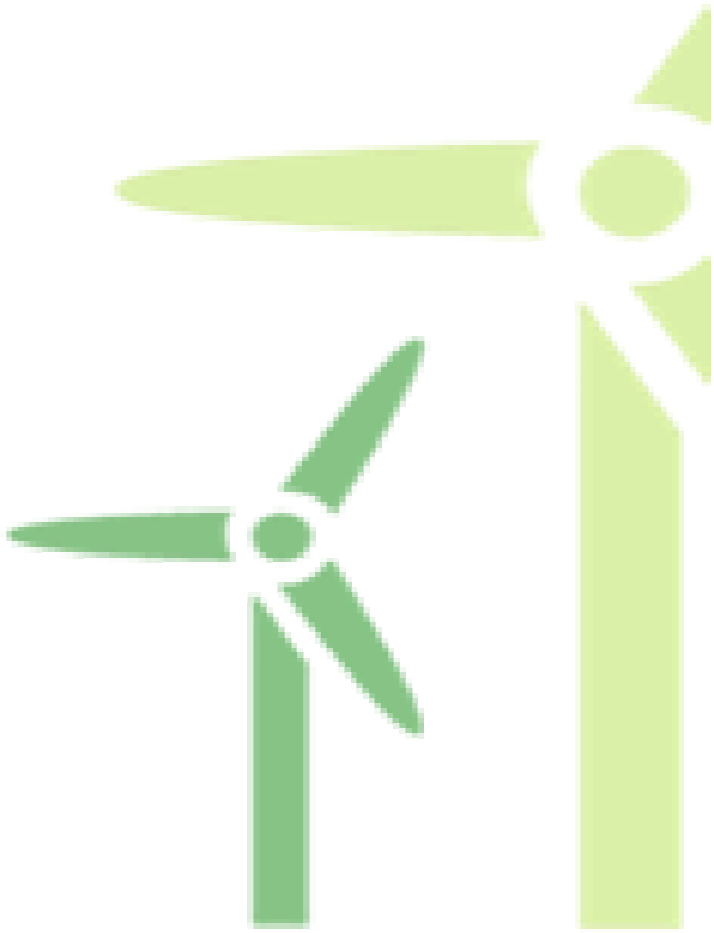
Agenda

1. Project Overview
2. Methodology
3. Hotspot Analysis
    a. Wind
    b. Solar
    c. Electrical equipment
    d. Transportation
4. Final recommendations
5. Sources



Enel Green Power North America (EGPNA)

Green Power

100+ Renewable energy power plants

3,200 MW Wind, solar, geothermal and hydropower

- **Owner and operator** of renewable energy plants in North America
- Present in **23 U.S. states** and **2 Canadian provinces**
- Headquartered in **Andover, MA**
- **450 employees**
- **Owned by Enel**, an Italian energy company and one of the world's leading integrated electricity and gas operators

Problem Statement

EGPNA is installing sustainable energy solutions


+

=


Are EGPNA's suppliers sustainable?


+

=
?

Which products have the greatest impact on the company's supply chain from the sustainability perspective?

Business Case

Goal State: Understand which products/categories have the greatest impact on the company's supply chain from the sustainability perspective, in order to initiate strategic collaborations with suppliers.

The successful development of this project will support two of EGPNA's strategic goals

- Embed Sustainability in EGPNA's Procurement (and Supply Chain) processes (a 3 year vision).
  - This project will kick-off the effort
- Improve EGPNA's Sustainability performance in front of investors and other stakeholders.
  - This project will develop a repeatable framework that will enhance EGPNA's reporting

Project Scope

- EGPNA seeks to improve the sustainability of its supply chain, but does not have an understanding of what components have the greatest impact.
- EGPNA has processes for managing sustainability in the construction, commissioning and operation of its facilities, but lacks a framework for its supply chain operations.
- <u>This project aims at providing:</u>
  - A **framework for evaluating** the sustainability of the components of EGPNA's supply chain.
  - A **pilot hotspot analysis**, to identify where to start and what indicators to use.
  - **Recommendations** on how to develop a repeatable process that will enable EGPNA to embed sustainability into its supply chain.

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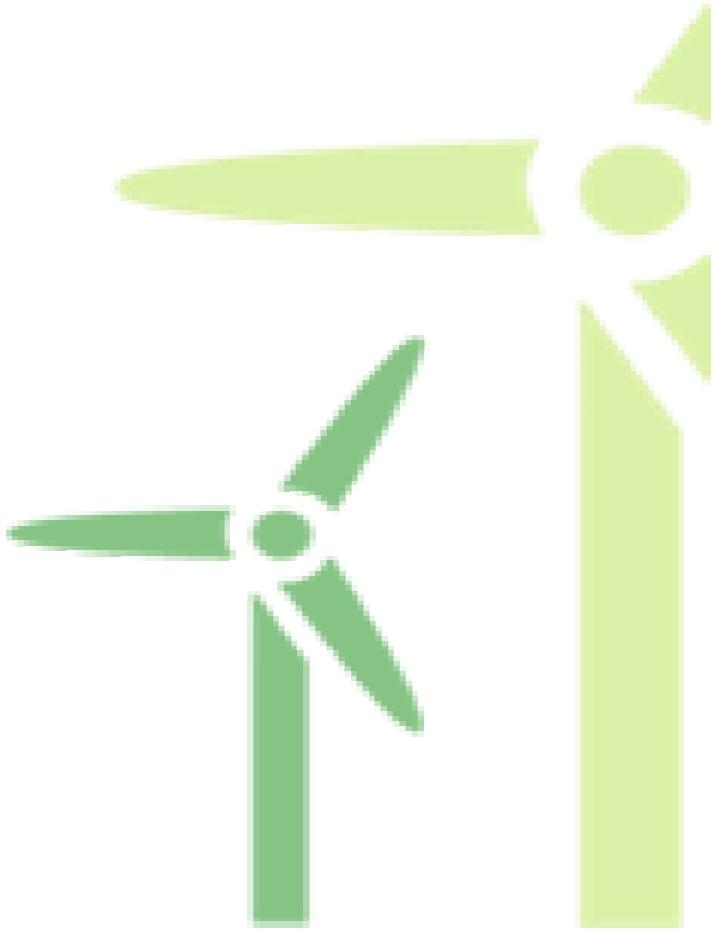
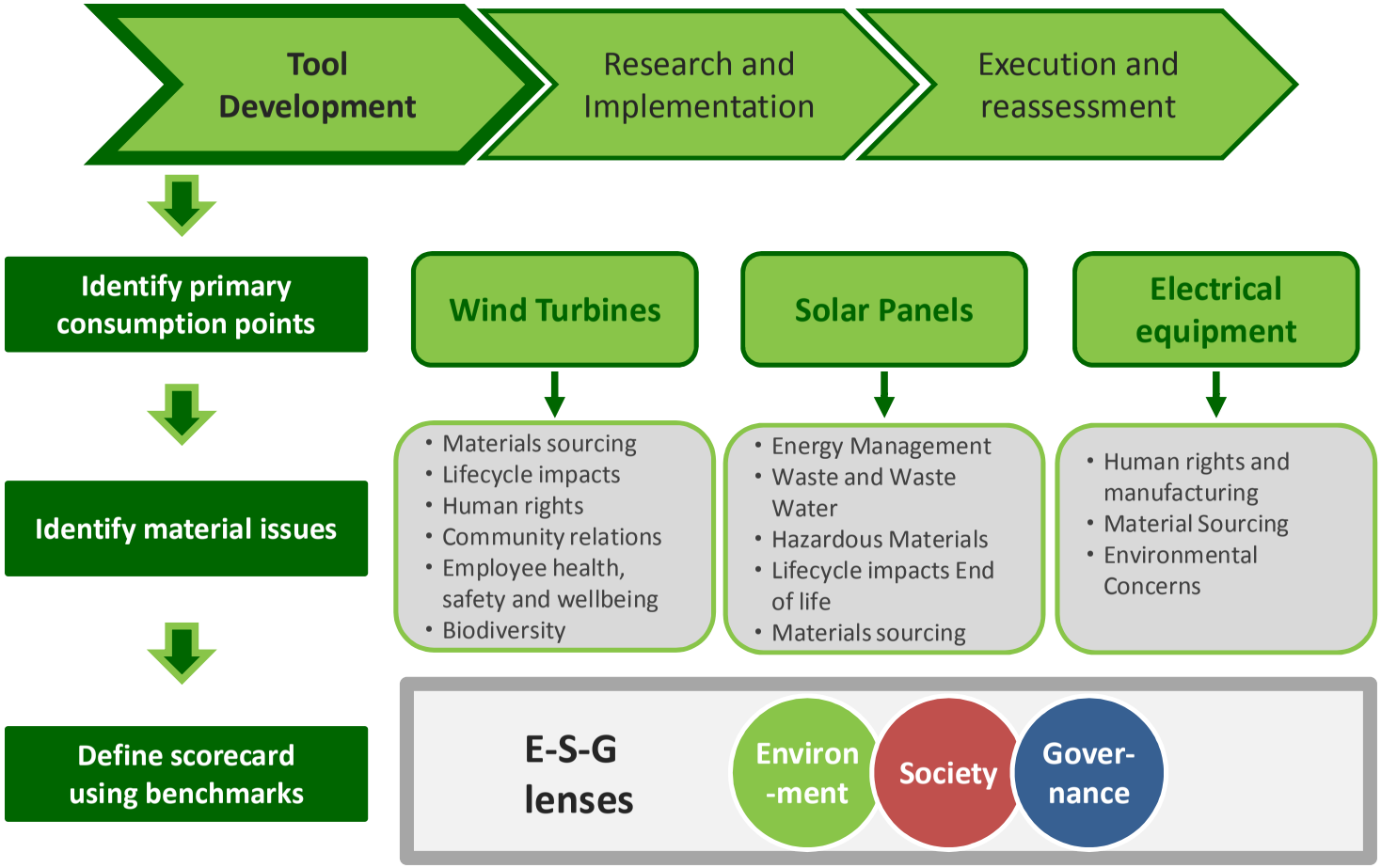
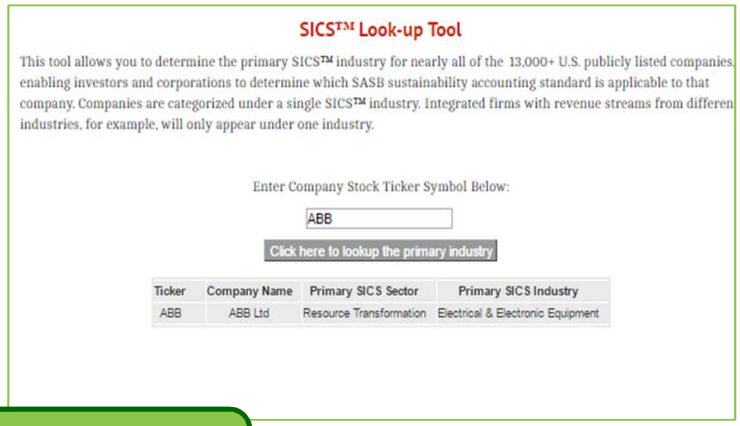


Methodology – Overview



Methodology - Primary consumption points

- Evaluate power plants bill of materials and purchasing schedules to determine essential components and manufacturers
- Look up components and manufacturers on SASB.org



Wind Turbines

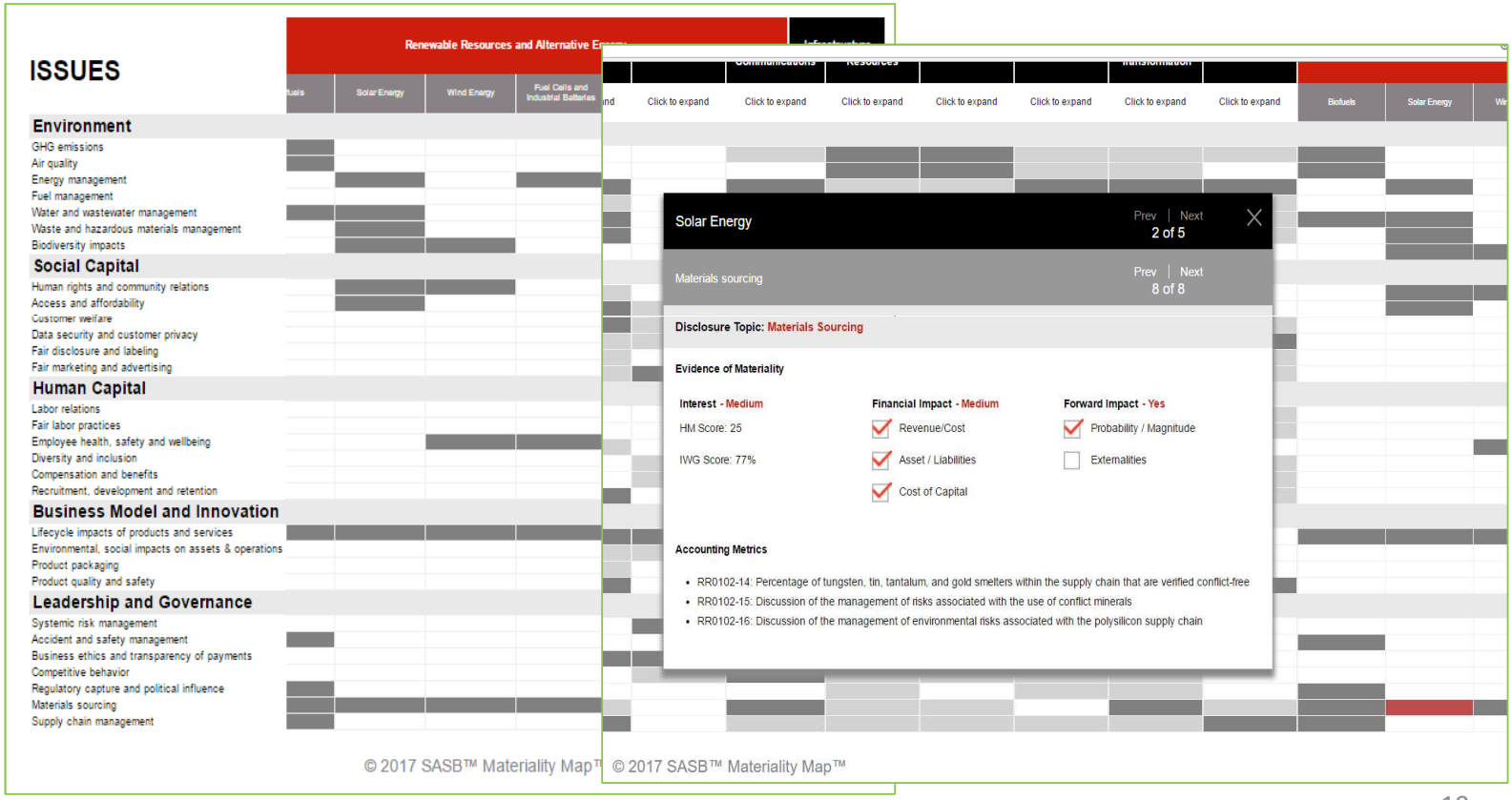
Solar Panels

Electrical equipment

https://www.sasb.org/sics/

Methodology - Material issues

- Use SASB Materiality Map to identify primary concerns for each industry



http://materiality.sasb.org/

Methodology - Use benchmarks

- Find sustainability **leaders**
- Find relevant **indicators**
  - SASB
  - Company Reports
  - Industry-relevant literature

Waste Generation	2014	2015
Total solid waste generated (metric tons)	7,124	7,560
Total solid waste recycled (metric tons)	6,288	6,601
Percent solid waste recycled (%)	88%	87%
Tons of solid waste generated per MW (metric tons/MW)	5.8	5.5
Total hazardous waste generated (metric tons)	8,781	8,225
Total hazardous waste recycled (metric tons)	5,822	6,486
Percent hazardous waste recycled (%)	66%	79%
Total hazardous waste generated per MW (metric tons/MW)	7.1	6.0

Water Use	2014	2015
Total Water Use (US Gallons)	2,035,493,986	2,249,660,501
Total Water Use (US Gallons) per MW	1,645,508	1,634,928

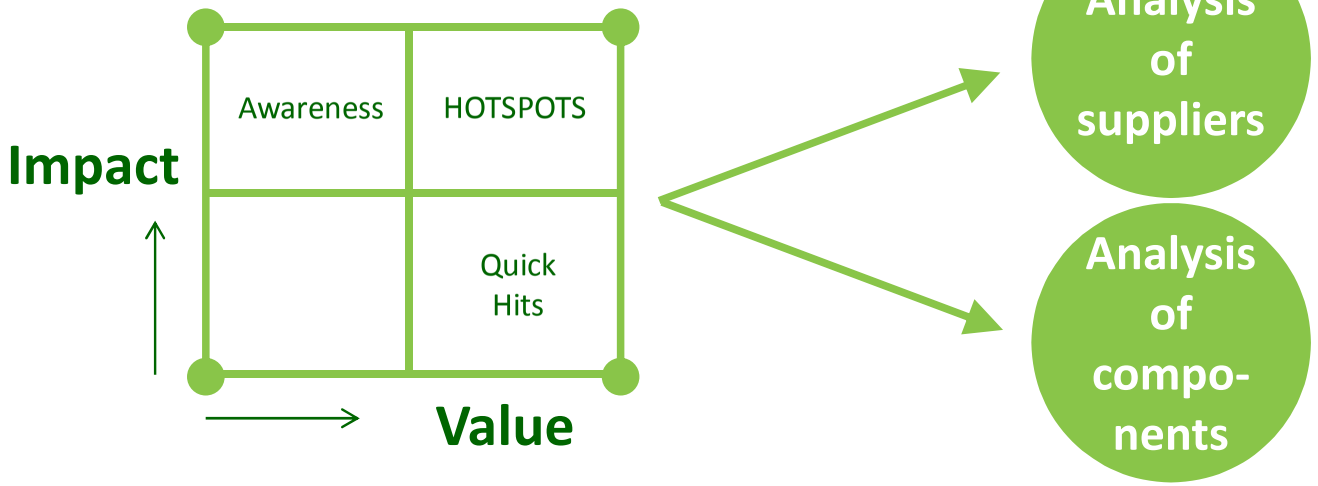
Energy Use	2014	2015
Total energy use (MWh)	456,521	478,778
MWh used per MW produced	363	348

S2

S1

Methodology - Hotspot analysis

HOTSPOT = Value X Impact



Methodology - Next steps

Once benchmark levels are set:

1. Collect and analyze EGPNA and its suppliers' data to determine the baseline level
2. Compare the baseline level with the benchmark using the tool
3. Collaborate with suppliers to determine new goals

Solar	Size (of Plant in MW)	4						
KPI	Benchmark	Weighting	FSLR	TRINA	Supplier C	A	B	B
Energy (MWh/MW)	348	1	267.3	221	410	23%	36%	-18%
Metric tons CO2/MW	225	1	124	182	308	45%	19%	-37%
water(Gals/MW)	1,634,928	1	361,001	497,960	2,200,000	78%	70%	-35%
Waste Water discharged (m^3/ MW)	5613	1	713.5	973	10000	87%	83%	-78%
Hazardous Waste recycled %	79%	1	70%	50%	5%	11%	37%	94%
Solid Waste Recycled %	88%	1	60%	40%	0%	32%	55%	100%
Society – Labor %	100%	1	100%	100%	50%	0%	0%	50%
Governance	100%	1	100%	100%	50%	0%	0%	50%
Cost ($/MW)	$ 1,000,000.00		$ 800,000.00	$ 1,100,000.00	$ 600,000.00	20%	-10%	40%

	Saved or Excess Waste		
Benchmark comparison	A	B	A
Energy used (MWh)	(323)	(508)	248
Metric tons CO2	(404)	(172)	332
water(Gals)	(5,095,708)	(4,547,870)	2,260,288
Waste Water discharged (m^3)	(19,598)	(18,560)	17,548
Hazardous Waste recycled %	-36%	-116%	-296%
Solid Waste Recycled %	-112%	-192%	-352%
Society – Labor %	0%	0%	-200%
Governance	0%	0%	-200%
Dollars	(800,000)	400,000	(1,600,000)

Data collected for benchmark (SUNPOWER), FSLR and TRINA referenced to S2, S3, S4 respectively

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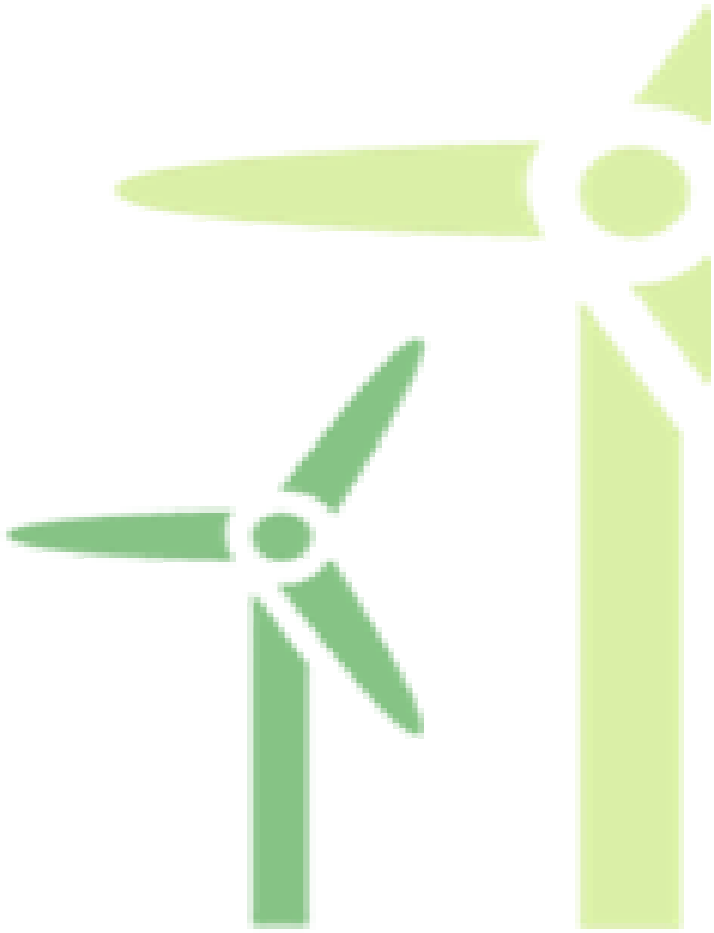


Wind - Overview

- **Largest category of Enel's purchases**

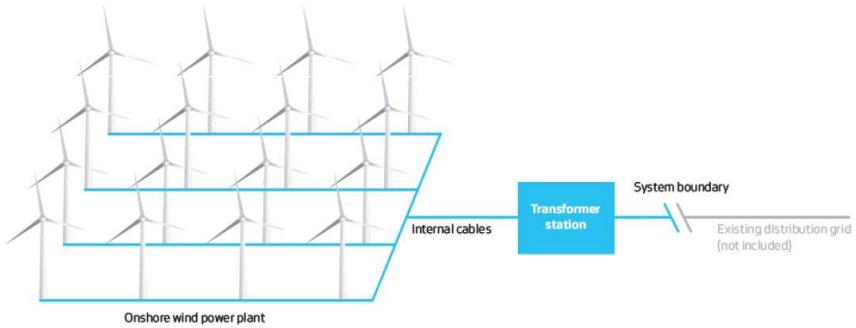
  69%, or €938M of the last 12 months' total purchases of €1.4b corresponded to wind plants, spare parts for wind turbine generators, and civil works equipment for wind power generation

- **Main suppliers**

  Vestas American Wind (59%)
  General Electric (13%)
  Nordex USA (8%)
  Michels Power (6%)

- **SASB**

  Materials sourcing
  Lifecycle impacts of products and services
  Human rights and community relations
  Employee health, safety and wellbeing
  Biodiversity impacts



Source and benchmark: Vestas LCA

Wind - Environmental Scorecard

Category	Indicator	Benchmark	Hotspots
Environment – Climate Change	• Return on energy	25 to 40	Plant siting and design Plant lifetime
	• Grams CO2 per kWh	6.9	Manufacturing of tower (29%), nacelle (17%), and foundations (15%) Transportation from supplier
	• % of production in the U.S.	80%	Tower manufacturing and nacelle assembly
	• 100% WindMade accreditation	Y	Use of renewable energy for operations
Environment – Waste	• % recyclability of the wind turbines	84.5	Non-metal components Use recycled metals or push its end-of-life recycling
Environment – Toxicity	• Terrestrial ecotoxicity potential (mg DCB-e / kWh)	41	Release of heavy metals (chromium, mercury and arsenic) to air (79%) and soil (21%) in manufacturing, mainly of the nacelle (31%) and tower (15%)
	• Freshwater ecotoxicity potential (mg DCB-e / kWh)	62	Manufacturing of cables (40%), due to polymer materials (PVC and PET) Distance to the grid (baseline 20km) Release of heavy metals such as nickel, vanadium and barium

Wind - Social Scorecard

Category	Indicator	Benchmark	Hotspots
Society – Toxicity	• Human ecotoxicity potential (mg DCB-e / kWh)	1427	Manufacturing of cables (50%) and tower (21%) Distance to the grid (baseline 20km) Recycling - If materials are not effectively recycled, the impact actually increases by a factor of 4.5x
Society – Safety	• Injuries in supply chain (per million working hours)	7	Construction and maintenance work Blade failure Safety distance from human activity Extend analysis to whole supply chain
Society – Labor	• Human Rights Policy	Y	Emerging markets c.f. of International Finance Corporation's Environmental and Social Performance Standards and the World Bank Group's Environmental, Health, and Safety Guidelines for Wind Energy
	• International Bill of Human Rights	Y	
	• International Labour Organization	Y	
	• Social Due Diligence	Y	

Injuries / M working h

ecotoxicity potential (mg DCB-e / kWh)

✓ Human Rights Policy
✓ Social Due Diligence

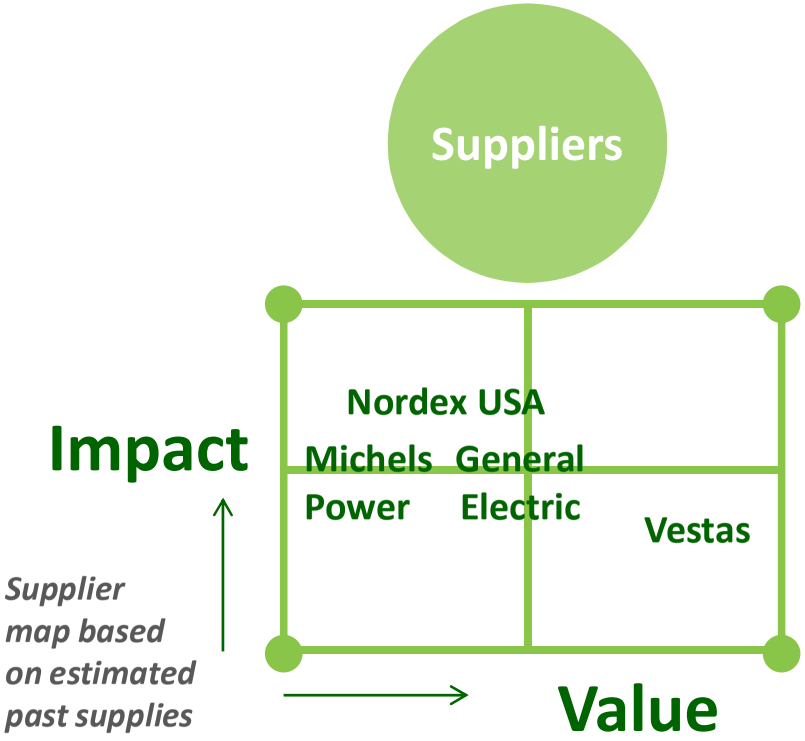
Wind - Governance Scorecard

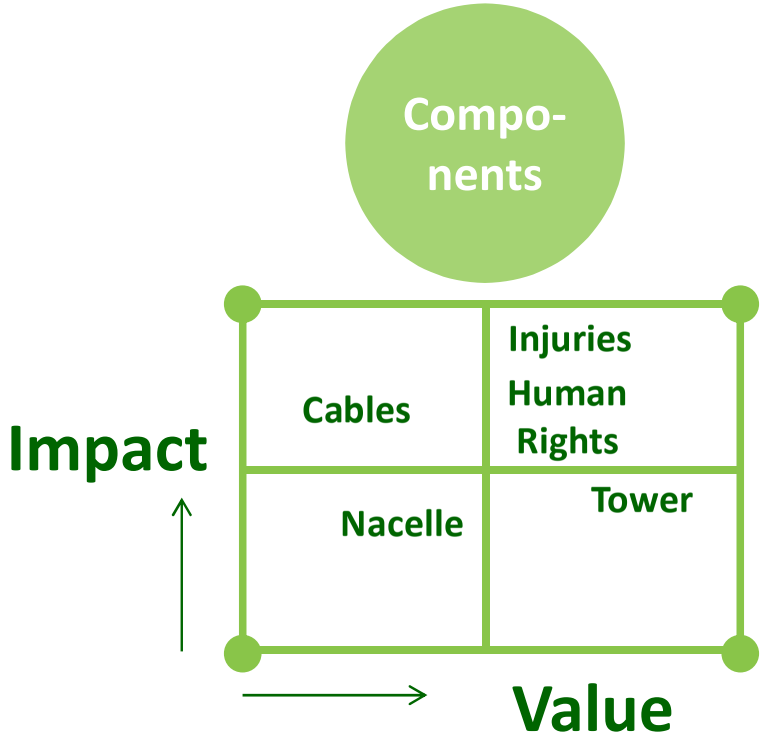
✓UN Global Compact
✓Employee Code of Conduct
✓Business Partner Code of Conduct

✓World Economic Forum's Partnering Against Corruption Initiative
✓Bribery Risk Assessment

✓Carbon Disclosure Project
✓Life Cycle Assessment of complete wind power plants

Wind - Hotspot Analysis





- Based on comparison of CSR criteria
- Compared scorecards of different companies
- Higher impact means worse sustainability performance for the company, comparatively

Wind - Conclusions

- **Supply chain** improvement is very material because manufacturing and end-of-life phases dominate the environmental impacts.

- **Manufacturing** stage dominates all potential environmental impacts. Consequently, a long life of operation significantly reduces overall impacts. Environmental impacts decrease by around 17% for an increased lifetime of 4 years (20% of the baseline 20 years).

- **Recycling**, represents the second most important phase because of its avoided potential impacts at end-of-life if conducted effectively.
  - The turbine is constructed of around 87% metal (primarily iron and steel, and to a lesser extent aluminium and copper).
  - It is very important to recycle turbines' materials to be able to account for the end-of-cycle credits of avoided impact.
  - Even better, the preferred way is to build the turbines with recycled metals altogether.

- **Transportation** from production locations to the wind plant has a high variability, as its share ranges between 1% and 40% depending on the category and location, justifying a more refined, case-by-case analysis.

Wind - Recommendations

- Request information on the **location** where the materials come from, as transportation can be as high as 40% of the impact, or as low as 1%.
- Adopt **Vestas's benchmark** as a starting reference, and update once a year if a better benchmark or goal is found.
- Collaborate with Vestas and other suppliers in measuring and improving **human rights** and safety in the extended supply chain.
- Collaborate in advancing the state of the art of **blade recycling and recyclability** since their composite material recovery is not yet established.
- Collaborate in advancing the use of **water footprint**. Vestas current LCA analysis takes into account freshwater used, but not the type of water, or the water scarcity of the region.
- Include in the analysis, in **sensitive communities**, the potential impacts of land use, deforestation, noise and local impacts on flora and fauna, generally included in Environmental Impact Assessments (EIA).

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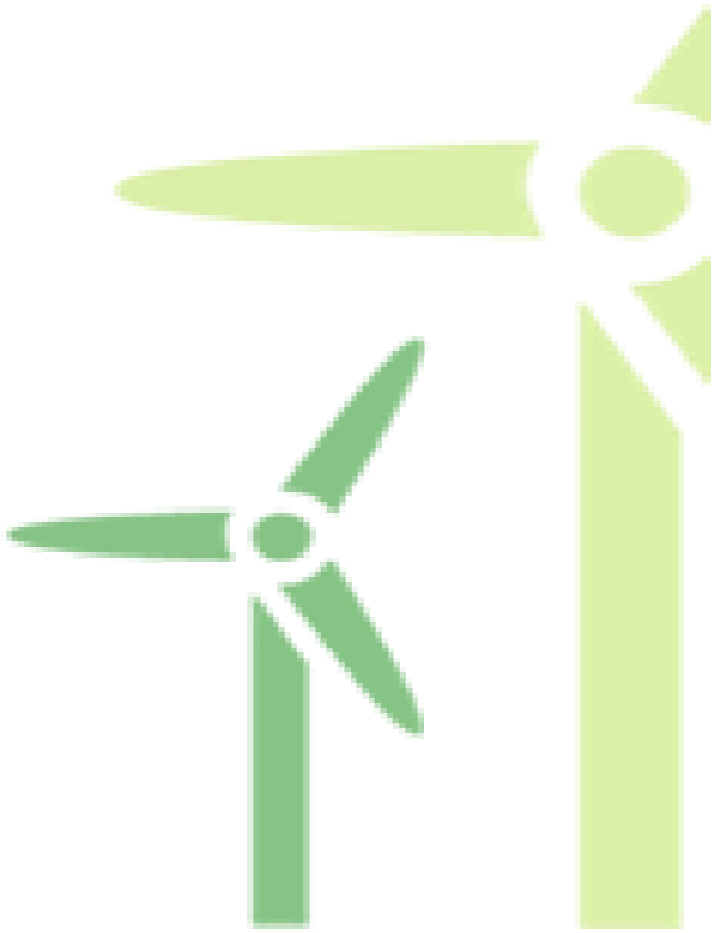
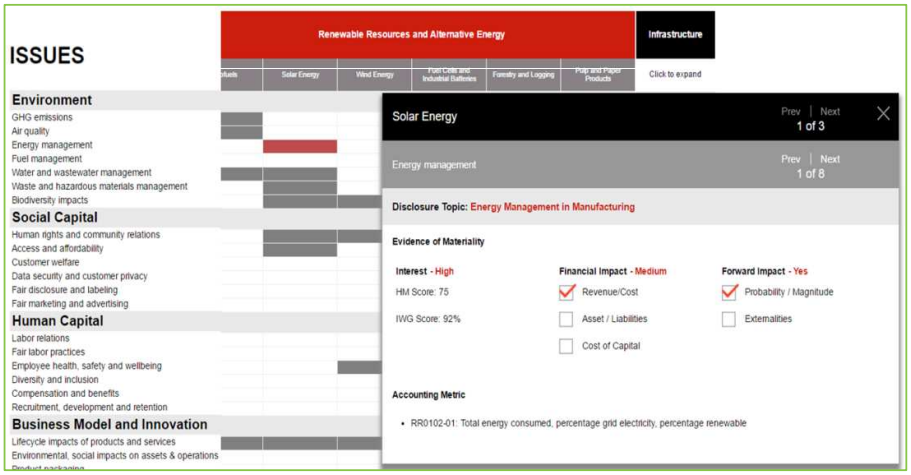


Solar - Overview

EXTRACTION	TRANSPORTATION	MANUFACTURING	TRANSPORTATION	INSTALLATION	OPERATION



In the coming years, most of EGPNA's new installed plants will be solar

SASB and SunPower CSR report

- **Energy Management**
- **Waste and Waste Water Management**
- **Hazardous Materials Management**
- **Lifecycle impacts of products and services**
  - **Products that are able to be recycled**
  - **End of life material recovered**
- **Materials sourcing**
  - **Tungsten, Tin, Tantalum, and Gold sourcing**
  - **Conflict materials**

Define Benchmarks

- Based off of multiple CSR's,
- SUNPOWER's solar panels are only Cradle to Cradle certified DC panels in the industry

SUNPOWER is one of the leaders in sustainability for solar

SUNPOWER has the only Cradle to Cradle certified DC panels in the industry

CERTIFIED cradle to cradle

Waste Generation	2014	2015
Total solid waste generated (metric tons)	7,124	7,560
Total solid waste recycled (metric tons)	6,288	6,601
Percent solid waste recycled (%)	88%	87%
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Energy Use	2014	2015
Total energy use (MWh)	456,521	478,778
MWh used per MW produced	363	348

S2

S1

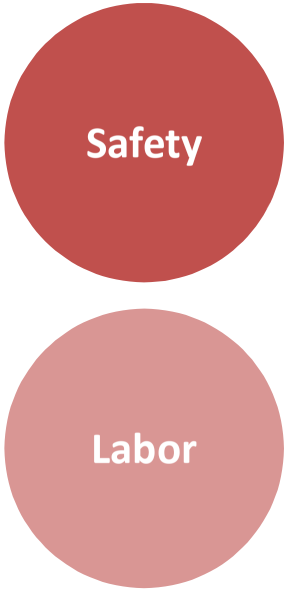
Solar - Environmental Scorecard

Category	Indicator	Benchmark	Comments
Environment – Climate Change	· Energy use (MWh per MW produced)	348	Manufacturing process
	· Metric tons of CO2 per MW produced	225	Includes Scope 1,2, and 3 GHG emissions
	· Water (gallons) use per MW produced	1,634,928	Manufacturing process
Environment – Waste	· Waste Water Discharged per MW (m^3/MW)	5,613	Manufacturing process
	· Solid Waste recycled	88%	Manufacturing process
Environment – Toxicity	· Hazardous waste recycled	79%	Manufacturing process

Energy MWh/MW **Tons of CO2 / MW** **Recyclability**

Data collected for benchmark (SUNPOWER) referenced in S2

Solar - Social Scorecard



- ✓ Injuries in supply chain <1.2 per million working hours
- ✓ Extend to the entire chain

- ✓ Human Rights Policy
- ✓ International Bill of Human Rights
- ✓ International Labour Organization
- ✓ Conflict Minerals Policy

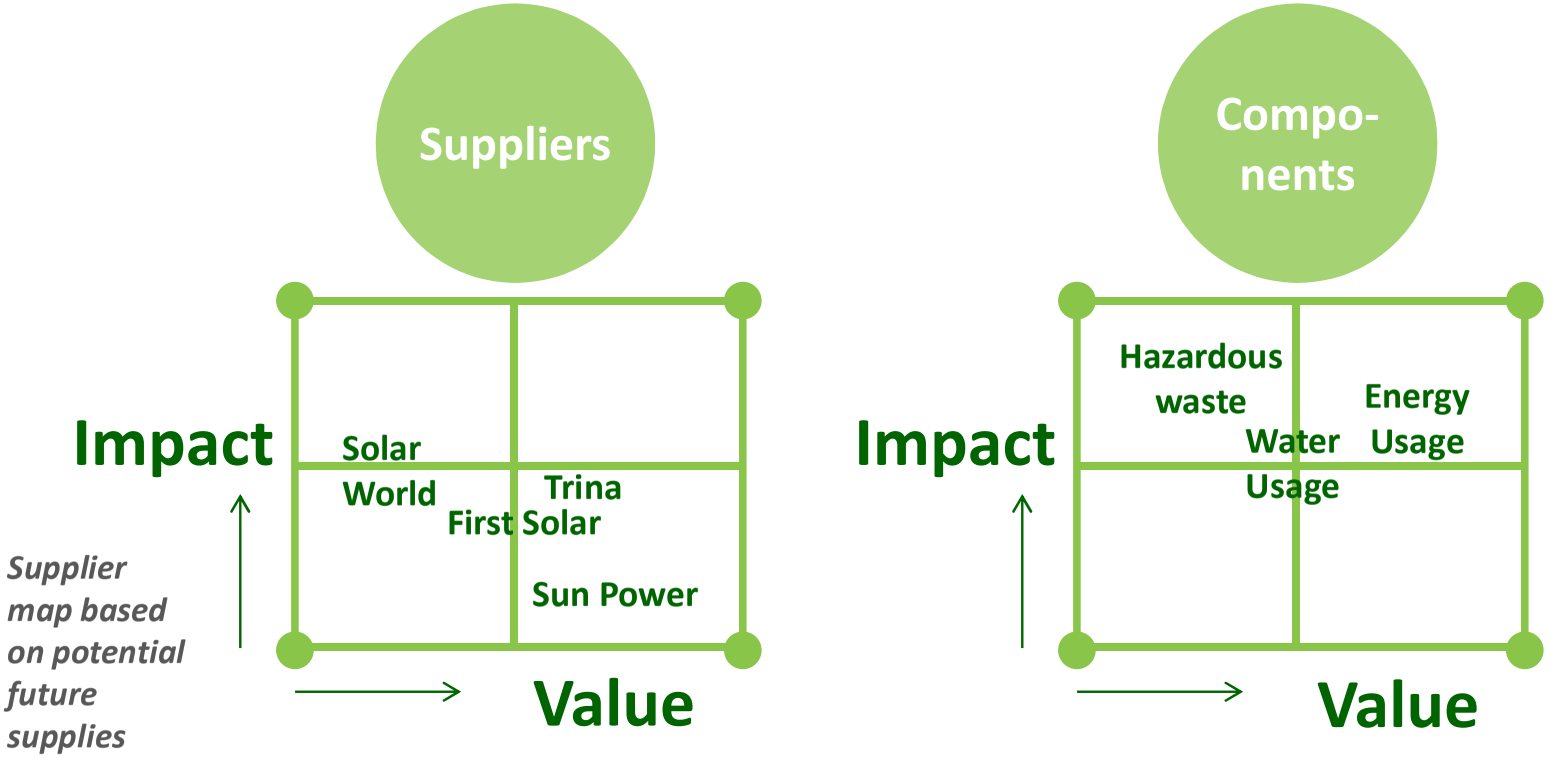
Solar - Governance Scorecard

✓UN Global Compact
✓Employee Code of Conduct
✓Business Partner Code of Conduct

✓World Economic Forum's Partnering Against Corruption Initiative
✓Supplier Certification and auditing

✓Carbon Disclosure Project
✓Corporate Sustainability Report

Solar - Hotspot Analysis



- Based on comparison of CSR criteria
- Compared scorecards of different companies
- Higher impact means worse sustainability performance for the company, comparatively

Solar - Recommendations

- Look for suppliers that have comprehensive **Governance and Social** policies similar to SunPower.
- Adopt **SunPower's benchmark** as a starting reference, and update once a year if a better benchmark or goal is found.
- Collaborate with suppliers to develop standard KPIs to measure then come up with plans of attack to improve
- Scope 1 and 2 Emissions are 90% of the emissions, focus on the energy reduction at the manufacturing plants
- Form relationships with suppliers that either champion sustainability initiatives or want to become more sustainable

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Electrical Equipment - Overview

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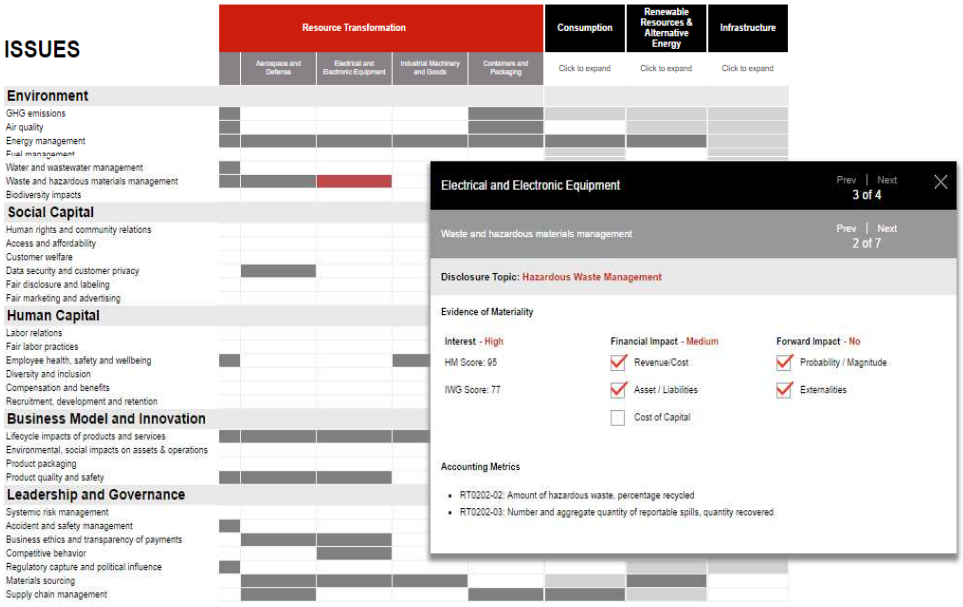


© 2017 SASB™ Materiality Map™

Main Suppliers

- Siemens
- ABB
- GE

Material Issues

- Energy Management
- Waste and Hazardous Materials Management
- Lifecycle impacts of products and services
- Product Safety
- Business Ethics and Competition
- Materials sourcing

Electrical Equipment - Environmental Scorecard

Category	Indicator	Benchmark	Comment
Environment – Energy Management	• Company - Percentage of renewable energy from total energy consumed [%]	5%	Green power is only purchased in Europe or US
	• Company Energy intensity [MWh per Million USD of sales]	75	
Environment – Climate Change	• GIS unit - SF6 Losses during Manufacturing [% w/w]	0.50	At end-of-life the switchgears are collected and the sulphur hexafluoride gas is reclaimed for reuse in new equipment.
	• GIS unit - SF6 Losses during Use Phase [% w/w per year]	0.10	
	• GIS unit - SF6 Losses at End of Life Phase [% w/w]	1.00	
Environment – Waste	• Power Transformer Unit - Energy Losses during Use Phase [kWh/ MVA]	413,000	
	• Company - Percentage waste recycled [%]	90%	
	• Power Transformer Unit - Recycle Waste at End of Life Phase [kg/MVA]	548	

Trafo Energy Losses MWh/ MVA

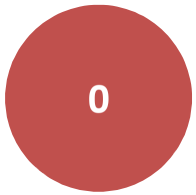
GIS SF6 Losses/ year

Recyclability

Electrical Equipment - Social Scorecard

Category	Indicator	Benchmark	Comment
Society – Employee H&S	• Employee total recordable incident rate [Incidents per 1,000 employees]	10	ILO rate
	• Employee Fatality Rate [Fatalities per 1,000 employees]	0	
Society – Product Safety	• Percentage of units recalled	0%	

Incidents Rate / 1,000 employees



Fatality Rate / 1,000 employees

Percentage Units Recalled

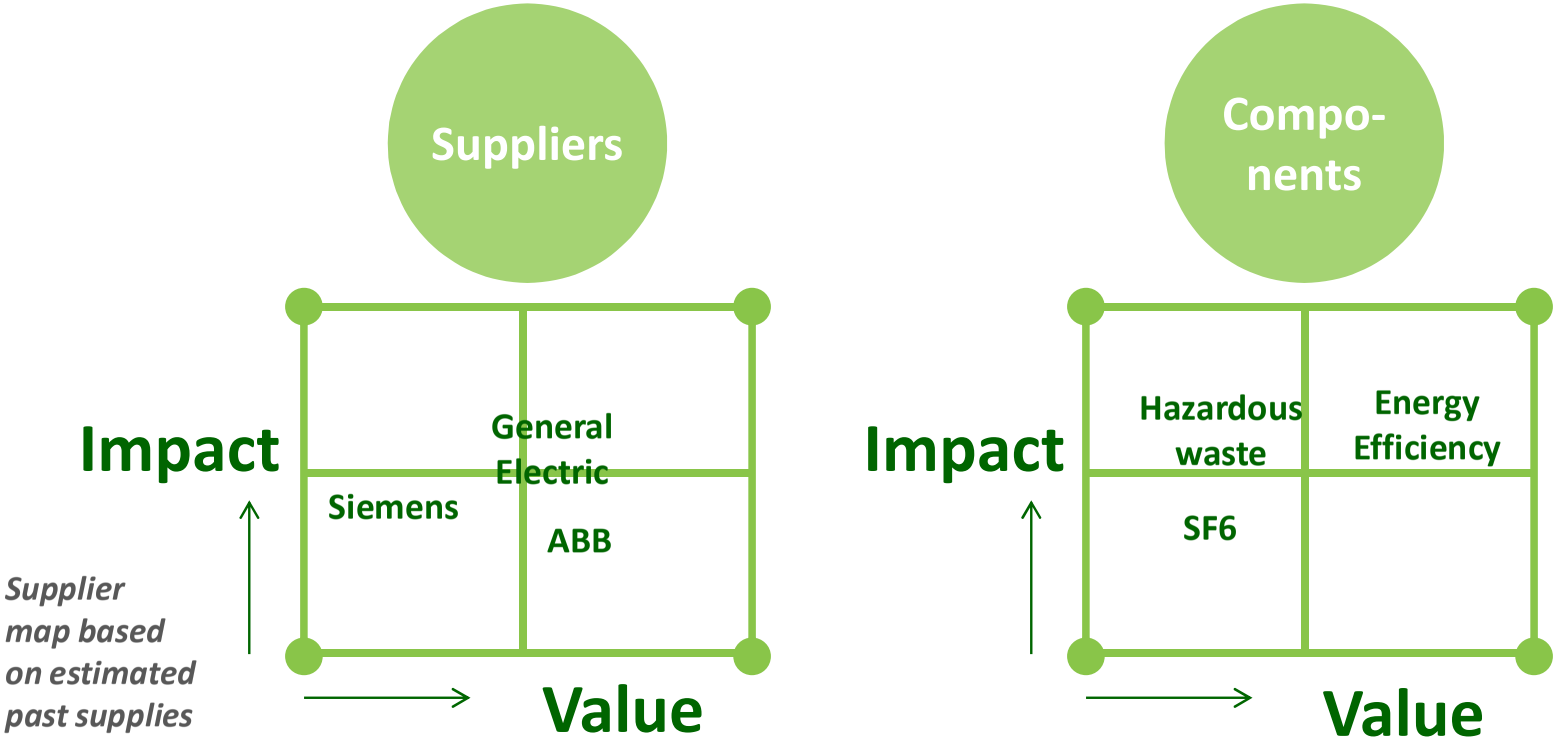
Electrical Equipment - Governance Scorecard

✓UN Global Compact
✓Employee Code of Conduct
✓Business Partner Code of Conduct

✓World Economic Forum's Partnering Against Corruption Initiative
✓Bribery Risk Assessment

✓Carbon Disclosure Project
✓Life Cycle Assessment

Electrical Equipment - Hotspot Analysis



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Electrical Equipment - Recommendations

- Target suppliers with increased % of **renewable energy** in electricity use, or planning to do so. Purchase of renewable energy is currently done mainly in Europe and the US.
- Favor suppliers that have transformers with technologies for **load loss reductions**.
- Target suppliers with comprehensive **recycling** policies.
- Target suppliers that have programs in place for **reclamation of GIS switchgears** at end of life phase.
- Explore switchgear suppliers that develop switchgears with **insulation fluids** other than SF6. Sulphur hexafluoride (SF6) is a very potent greenhouse gas, which is used in switchgears for medium- and high-voltage applications.
- No critical or conflict minerals are used in transformers or switchgears.

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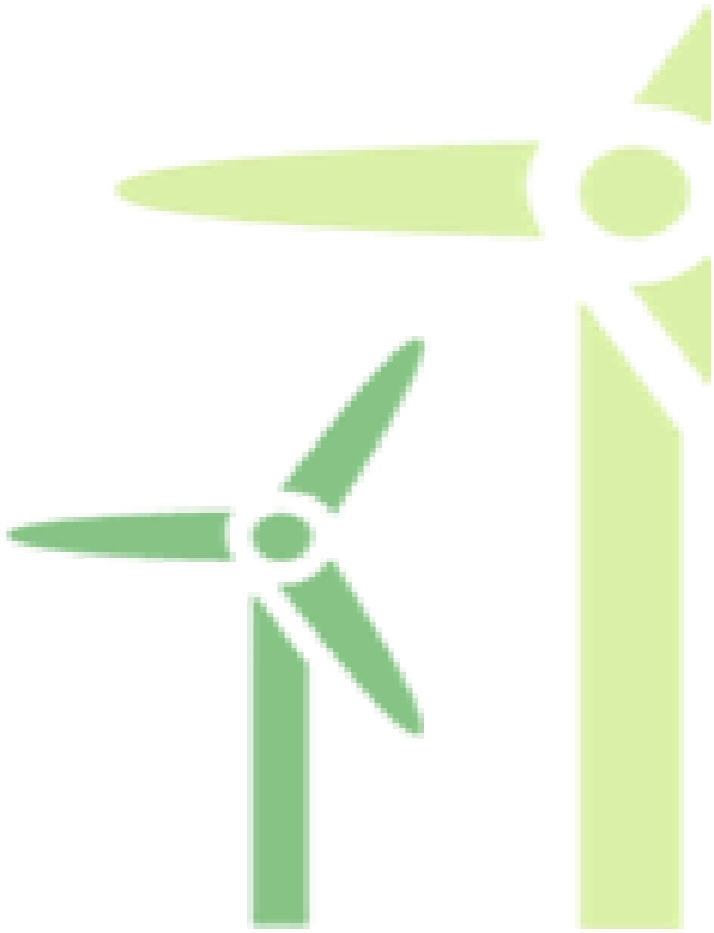


CO2 From Transportation of Bulky Items

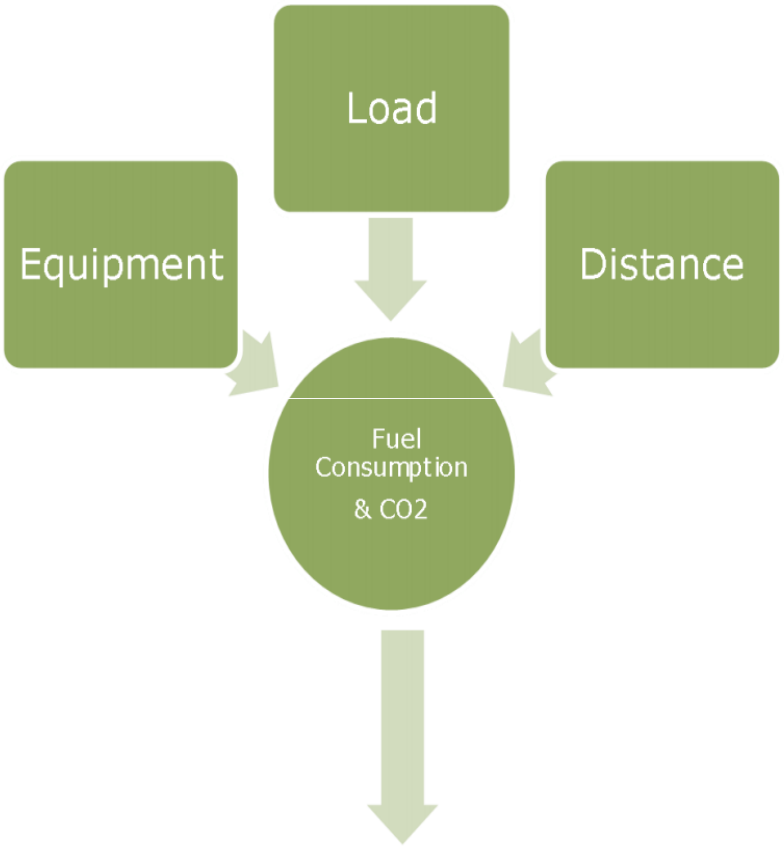
Other metal equipment

Blades and Towers

Trackers

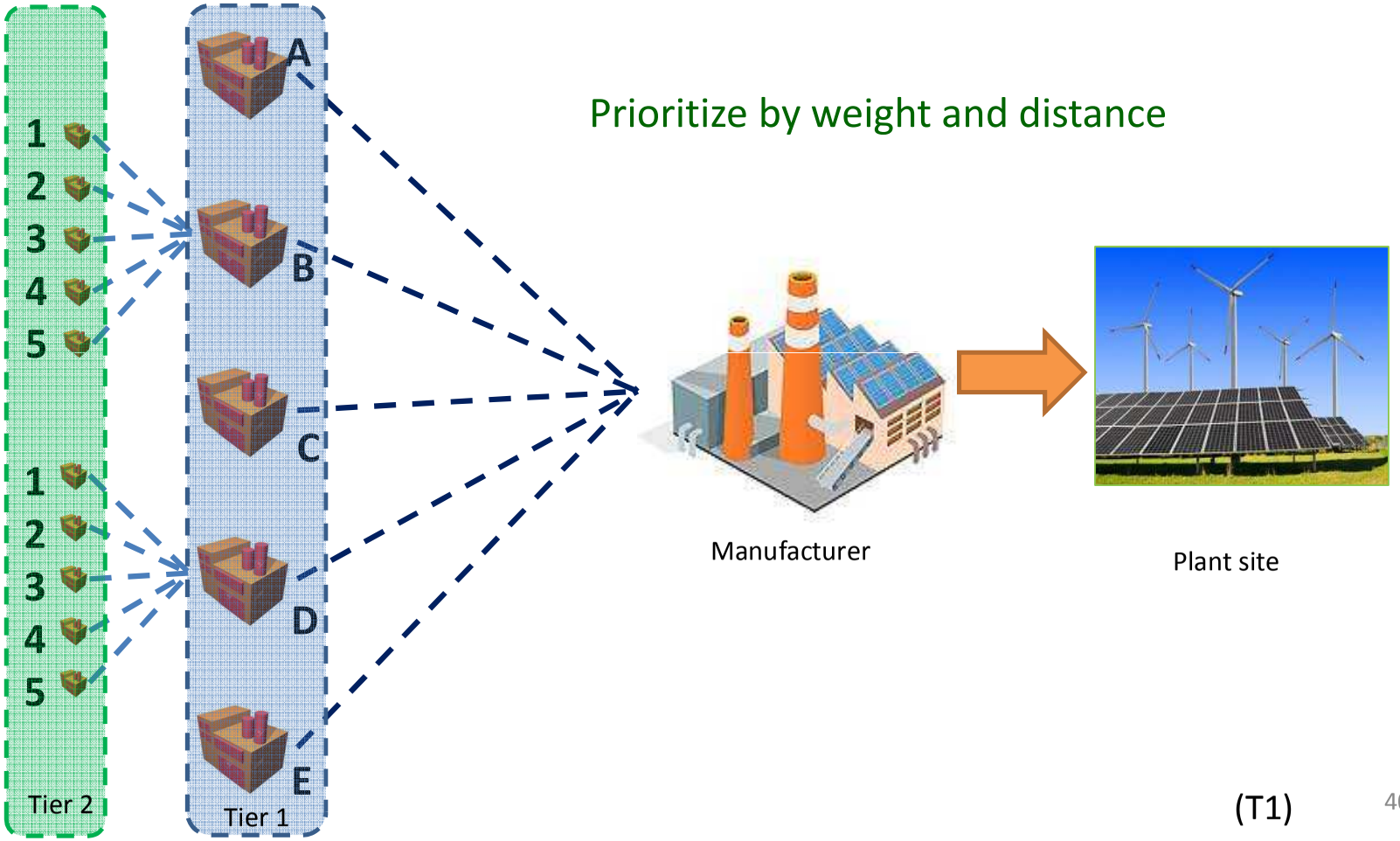
Copper

Transportation - CO2 emissions framework



Emission Factor (Kg CO_2 / ton-km) * Weight (ton) * Distance (km)

Transportation - CO2 emissions top suppliers analysis



(T1)

Transportation - CO2 emissions top suppliers analysis

IAW with GHG Protocol Scope 3 Calculation Guidance (T1)

1. Have manufacturer determine the top 5 components by weight
2. Determine the distance and mode of transportation between each supplier
3. Have Tier 1 suppliers determine the top 5 components that are sourced by weight
4. Determine the distance and mode of transportation between each supplier
5. Fill in the table with weight of components per unit and enter the number of units, and the distances for each mode of transportation

CO2 from transportation – Tool

CO2 from transportation of suppliers						Input
Metric tons CO2 per MW of Solar	1080.142					Output
MW of Solar produced	4					
Total CO2 produced from transportation (metric tons)	4320.567					

Transportation method	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)
CO2 Per ton mile	0.086	0.032	0.016	2.528	0.912

Manufacturer to site

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Miles	100	100	100	100	100	357.4

Top 5 (by weight) Tier 1 suppliers to Manufacturer in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier A	100					1.72
Supplier B			8000			38.4
Supplier C				300		113.76
Supplier D					2000	182.4
Supplier E		500				0.8

Top 5 (by weight) Tier 2 suppliers to Supplier A in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier A1	100					0.172
Supplier A2			8000			3.84
Supplier A3				300		30.336
Supplier A4					2000	91.2
Supplier A5		500				0.32

Top 5 (by weight) Tier 2 suppliers to Supplier B in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier B1	100					0.516
Supplier B2			8000			5.12
Supplier B3				300		53.088
Supplier B4					2000	18.24
Supplier B5		500				0.32

Top 5 (by weight) Tier 2 suppliers to Supplier C in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier C1	100					0.086
Supplier C2			8000			1.28
Supplier C3				300		53.088
Supplier C4					2000	54.72
Supplier C5		500				0.32

Top 5 (by weight) Tier 2 suppliers to Supplier D in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier D1	100					0.086
Supplier D2			8000			1.28
Supplier D3				300		15.168
Supplier D4					2000	36.48
Supplier D5		500				0.16

Top 5 (by weight) Tier 2 suppliers to Supplier E in miles

	Truck	Rail	Ocean	Air (Short)	Air (Longhaul)	Total CO2
Supplier E1	100					0.086
Supplier E2			8000			1.28
Supplier E3				300		0.07584
Supplier E4					2000	18.24
Supplier E5		500				0.16

Unit breakdown by weight

Unit Weight (tons)	1	Percentage of unit weight
Supplier A	0.2	20%
Supplier B	0.3	30%
Supplier C	0.15	15%
Supplier D	0.1	10%
Supplier E	0.05	5%
Total of Top 5 Tier 1 suppliers	0.8	80%

Supplier A Unit breakdown by weight

Unit Weight (tons)	0.2	Percentage of unit weight
Supplier A1	0.02	2%
Supplier A2	0.03	3%
Supplier A3	0.04	4%
Supplier A4	0.05	5%
Supplier A5	0.02	2%
Total of Top 5 Tier 2 suppliers	0.16	80%

Supplier B Unit breakdown by weight

Unit Weight (tons)	0.3	Percentage of unit weight
Supplier B1	0.06	6%
Supplier B2	0.04	4%
Supplier B3	0.07	7%
Supplier B4	0.01	1%
Supplier B5	0.02	2%
Total of Top 5 Tier 2 suppliers	0.2	67%

Supplier C Unit breakdown by weight

Unit Weight (tons)	0.15	Percentage of unit weight
Supplier C1	0.01	1%
Supplier C2	0.01	1%
Supplier C3	0.07	7%
Supplier C4	0.03	3%
Supplier C5	0.02	2%
Total of Top 5 Tier 2 suppliers	0.14	93%

Supplier D Unit breakdown by weight

Unit Weight (tons)	0.1	Percentage of unit weight
Supplier D1	0.01	1%
Supplier D2	0.01	1%
Supplier D3	0.02	2%
Supplier D4	0.02	2%
Supplier D5	0.01	1%
Total of Top 5 Tier 2 suppliers	0.07	70%

Supplier E Unit breakdown by weight

Unit Weight (tons)	0.05	Percentage of unit weight
Supplier E1	0.01	1%
Supplier E2	0.01	1%
Supplier E3	0.0001	0%
Supplier E4	0.01	1%
Supplier E5	0.01	1%
Total of Top 5 Tier 2 suppliers	0.0401	80%

(T1)

Agenda

1. Project Overview
2. Methodology
3. Hotspot Analysis
    a. Wind
    b. Solar
    c. Electrical equipment
    d. Transportation
4. **Final recommendations**
5. Sources

Final recommendations

1. Define **criteria to select suppliers**, weighting in the different prioritized impacts.
   - Use the scorecards of this project as checklists.
   - Update the benchmarks once a year.
   - Select suppliers that report on material issues according to SASB's Materiality Map.
2. Request an LCA or at least a detailed **impact analysis** to suppliers following Vestas and Sunpower's examples.
3. Request an analysis of the **local social impact** of these suppliers on their communities as well.
4. Collaborate with Vestas, Sunpower, ABB and other suppliers in measuring and improving human rights and safety in the extended supply chain.
5. Assess the specific impact of **transportation**, by asking about the origin of components to suppliers.
6. Consider using a **price for carbon** to inform internal purchasing decisions.
7. Collaborate in advancing the use of **water footprint**, taking into account types of water and local water scarcity.
8. Lead **stakeholder dialogue** and local community development.

Next steps

1. **Implement the scorecards**
    a. **Break down into components** each of the categories analyzed (Wind, Solar, Electrical Equipment).
    b. For each component, **create benchmark scorecards**, derived from the scorecards provided in this project, and add further component-specific sustainability requirements.
    c. Include the criteria as part of the **tenders**
    d. **Assess suppliers** in regard to the key indicators and hotspots identified, using the scorecards.
2. Use the assessment for purchasing decisions, and **collaborate with suppliers** to improve the metrics.

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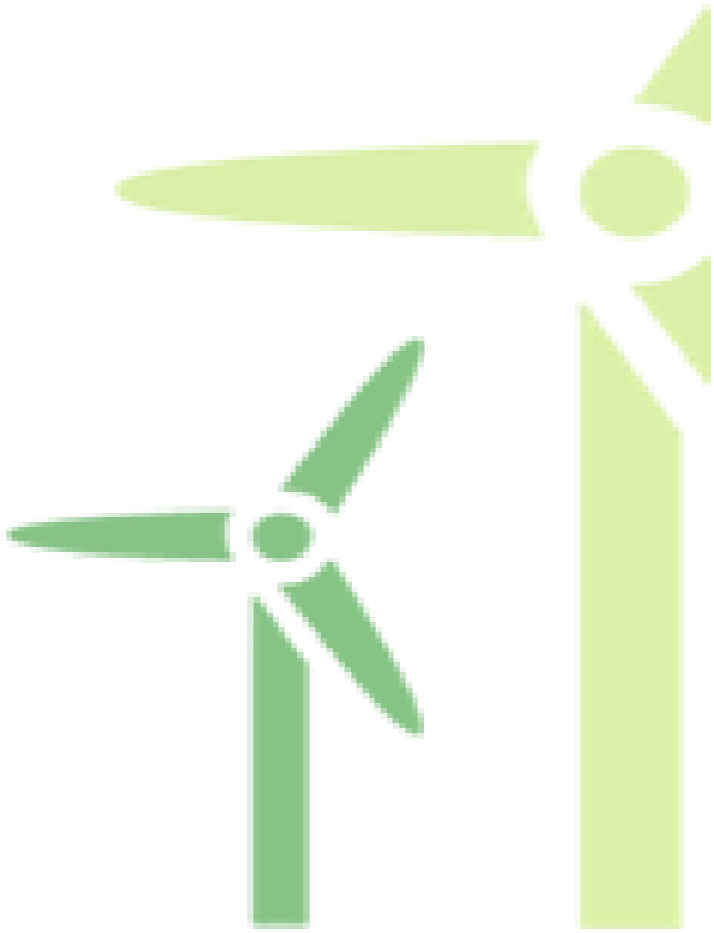

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