Understand the situation at hand

Setting ENERGY Targets

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

At the end of this module you will be able to…

Develop energy baselines, objectives, and targets

Content

- Developing Energy Balance
- Significant Energy Uses
- Energy Performance Indicators
- Energy Baselines
- Normalizing EnPIs
- Practical Exercise – The Textile Company

References

Higg FEM Questions

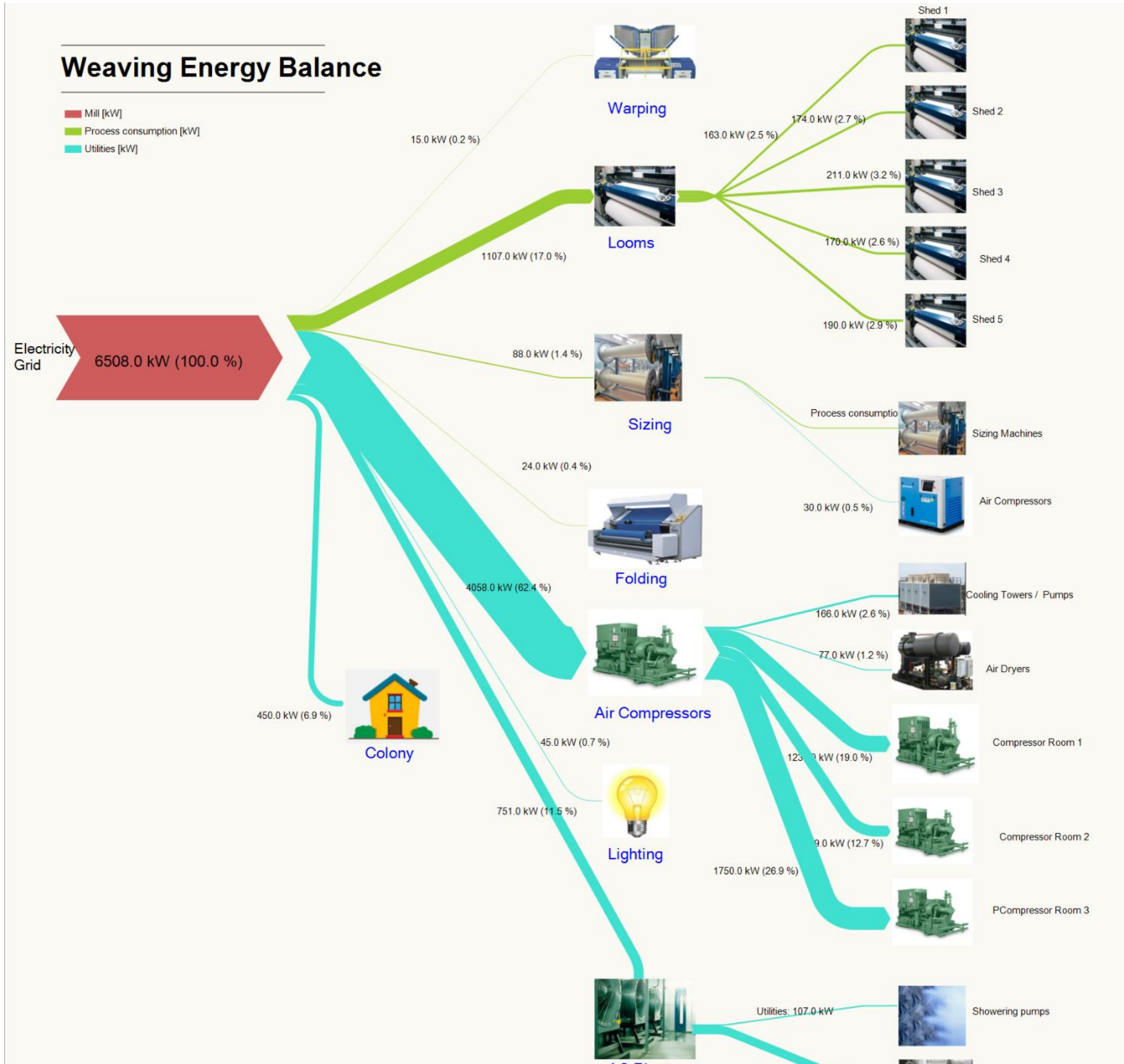
- Track and measure energy use from the sources
- Standardize methods and frequency to track each energy source
- Establish energy baselines
- Identify energy intensive processes or operations
- Set targets for improving energy use
- Set targets for reduction of GHG emissions (Scope-1 and Scope-2)

Energy Balance

- The purpose of an energy balance is to look at energy consumption on a smaller (individual energy uses) scale
- Using estimates and spot measurements of equipment loads, the energy consumed by each user can be found
  - ✓ **Energy Consumption = Nominal equipment rating x Duty Factor x Load Factor x Operating Hours**
- Individual loads are summed and compared to the plant energy input
- Areas of significant energy use (SEUs) are identified. SEUs can be facilities, systems, processes, or equipment
  - ✓ This ensures that we focus on biggest energy users first where bigger savings can be achieved
  - ✓ Also helps in reducing effort of measurement and monitoring
  - ✓ It is important to identify relevant variables affecting SEUs

HO 130003_Example Energy Balance

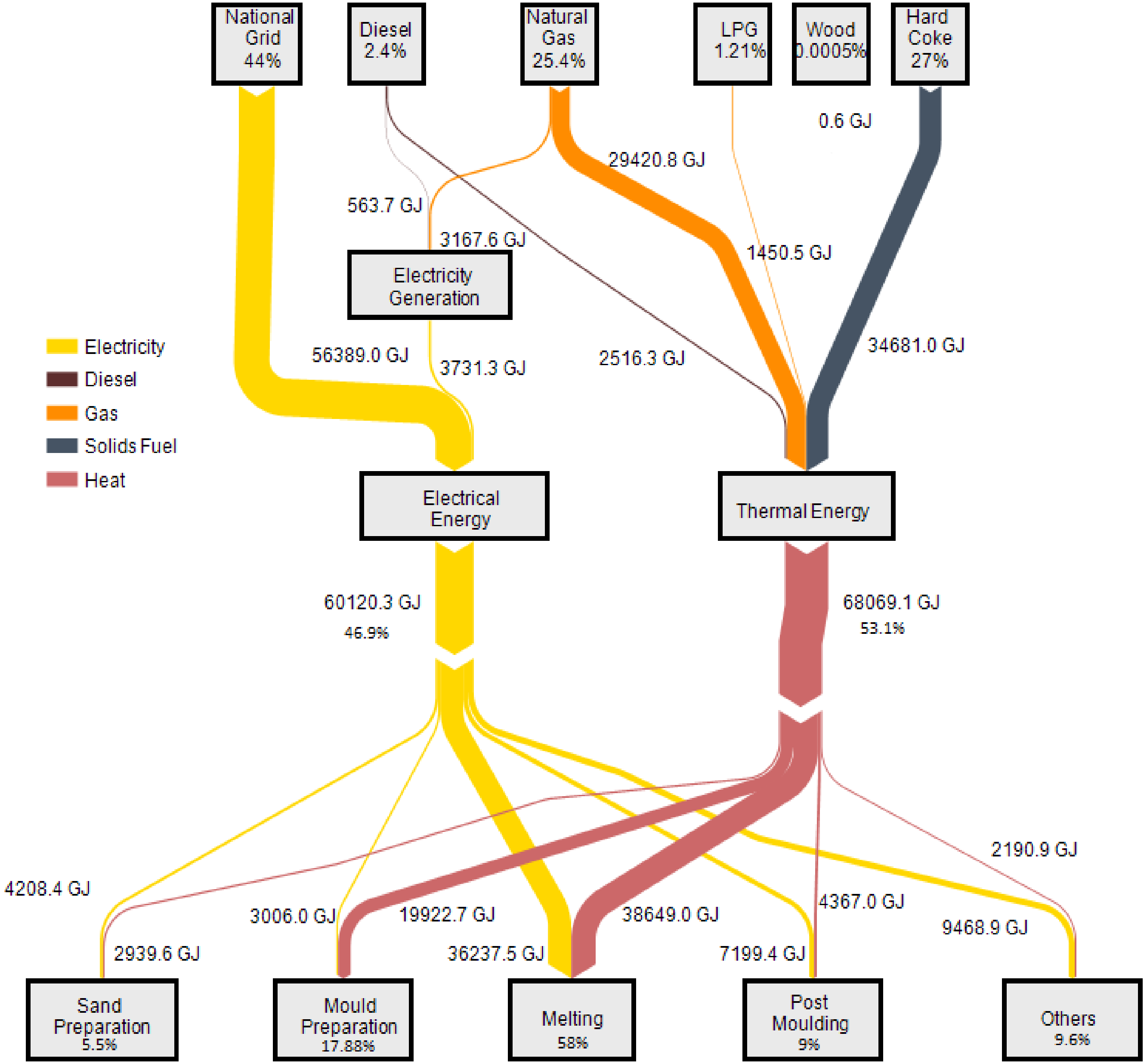
Energy Balance – Example (Weaving)



Source: Espire Consult

giz

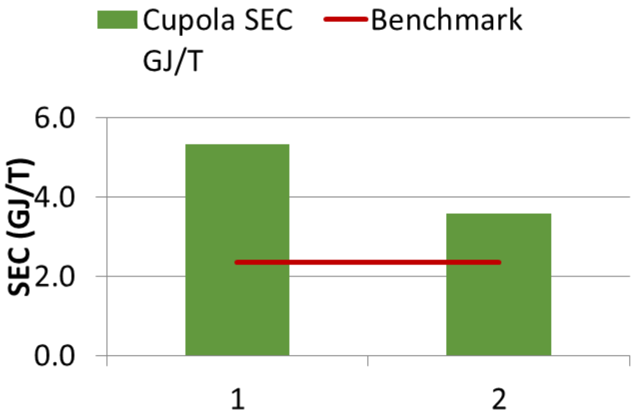
Energy Balance – Example (Foundry)

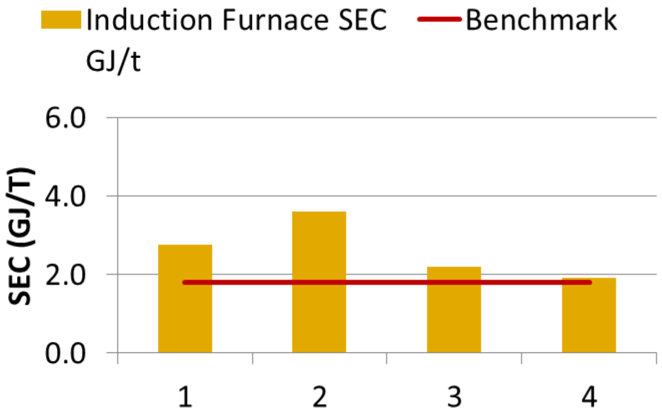


Source: Espire Consult

Energy Performance Indicators (EnPIs)

- Energy Performance Indicators are measurable indicators related to energy efficiency, energy use and energy consumption
  - ✓ e.g. GJ/Year, or GJ/kg-fabric
- EnPIs must be appropriate for measuring and monitoring energy performance
  - ✓ covering all energy sources and all SEUs
- EnPIs enable the organization to demonstrate energy performance improvement
  - ✓ comparing current values against baseline





Energy Baselines (EnBs)

- Quantitative reference providing a basis for comparison of energy performance e.g. Energy consumed in Year 2020
- An energy baseline is based on data from a specified period and/or conditions e.g. January – December 2020
- Baselines can be Absolute (e.g., 120,000 GJ/year) or Normalized (e.g., 6.5 GJ/Tonne-production).
- Relevant variables may significantly affect energy performance requiring normalization, e.g.,
  - ✓ environmental temperature
  - ✓ Humidity
  - ✓ raw material type
- Depending on the nature of the activities, normalization can be a simple adjustment, or a more complex procedure.

Energy Performance

Which one is better?

Company	**Energy Consumption** GJ/y
A	73,843
B	108,540

Energy Performance

Which one is better?

Company	Energy Consumption GJ/y	Production T/y	SEC GJ/T
A	73,843	13,244	5.58
B	108,540	4,399	24.68

giz

Energy Performance

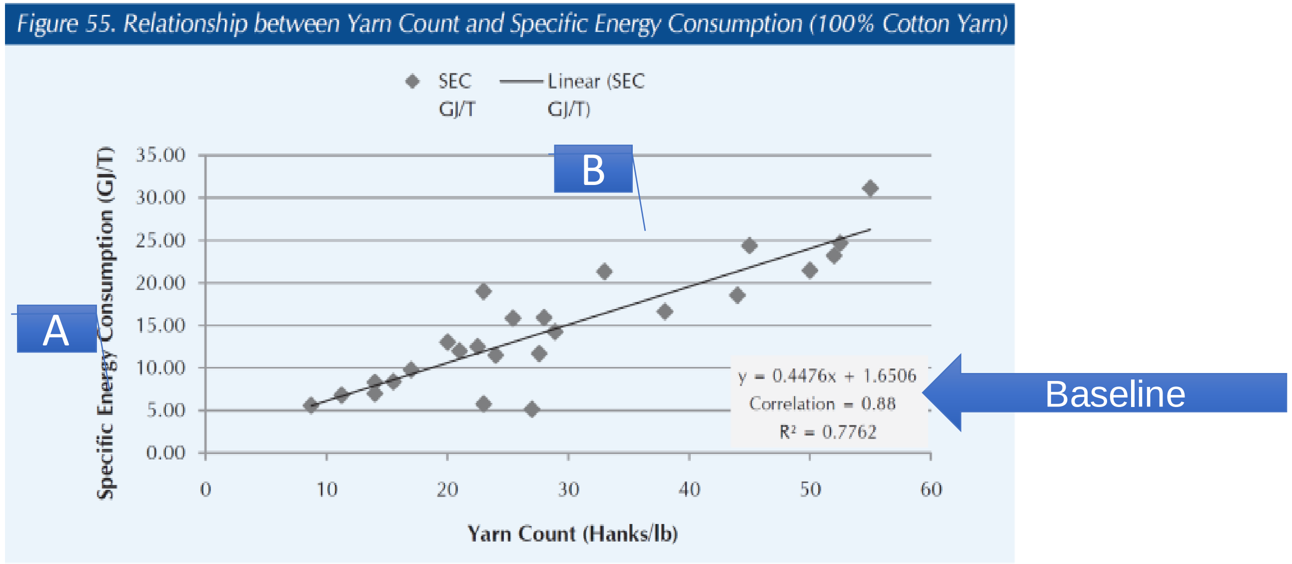
Which one is better?

Company	**Energy Consumption** GJ/y	**Production** T/y	**SEC** GJ/T	**Yarn Count** Hanks/lb
A	73,843	13,244	5.58	8.72
B	108,540	4,399	24.68	52.5

Energy Performance

Which one is better?

Company	Energy Consumption GJ/y	Production T/y	SEC GJ/T	Yarn Count Hanks/lb
A	73,843	13,244	5.58	8.72
B	108,540	4,399	24.68	52.5



Source: UNIDO Sectoral Analysis on Renewable Energy and Energy Efficiency, July 2019

Normalizing the EnPIs

Plenary discussion

- Which variables significantly effect energy performance of your key processes?
- How can these variables be measured?

Normalizing the EnPIs

Finding the significant variables - Example

Multiple Variables may be listed based on experience or expert advice

Sr. No	Type of Metering	EnPI	Department	Relevant Variables
1	Electricity	kWh/meter	Sizing	1. Yarn Count. 2. Beam width. 3. No. of Ends
2	Steam	kg./1000 meters	Sizing	1. Yarn Count. 2. Beam width. 3. No. of Ends
3	Electricity	kWh/1000 meters	Warping	1. Yarn Count. 2. Beam width. 3. No. of Ends
4	Electricity	kWh/meter	Weaving	1. GSM 2. Fabric width.
5	Electricity	kWh/meter	Folding	1. GSM 2. Fabric width
6	Electricity, Air Flow	kWh/m³	Compressed Air	1. Working Pressure 2. Ambient Temperature 3. EnPI of compressor
7	Air Flow	m³/1000 meters	Weaving Shed	1. GSM 2. Fabric width.

Normalizing the EnPIs

Seasonal Variation

- Seasonal variation can be converted into quantified variable i.e. HDD or CDD
  - ✓ "Heating degree days", or "HDD", are a measure of how much (in degrees), and for how long (in days), outside air temperature was lower than a specific "base temperature" (or "balance point").
  - ✓ "Cooling degree days", or "CDD", are a measure of how much (in degrees), and for how long (in days), outside air temperature was higher than a specific base temperature
- Degree days are based on the assumption that when the outside temperature is (say) 24°C in Pakistan we don't need heating or cooling to be comfortable.
- Degree days are the difference between the daily temperature mean, and 24°C.
  - ✓ If the temperature mean is above 24°C, we subtract 24 from the mean and the result is Cooling Degree Days.
  - ✓ If the temperature mean is below 24°C, we subtract the mean from 24 and the result is Heating Degree Days.

Normalizing the EnPIs

HDD and CDD Examples

- The high temperature for a particular day was 37°C and the low temperature was 22°C. The temperature mean for that day was:

  (37°C + 22°C) / 2 = 29.5°C

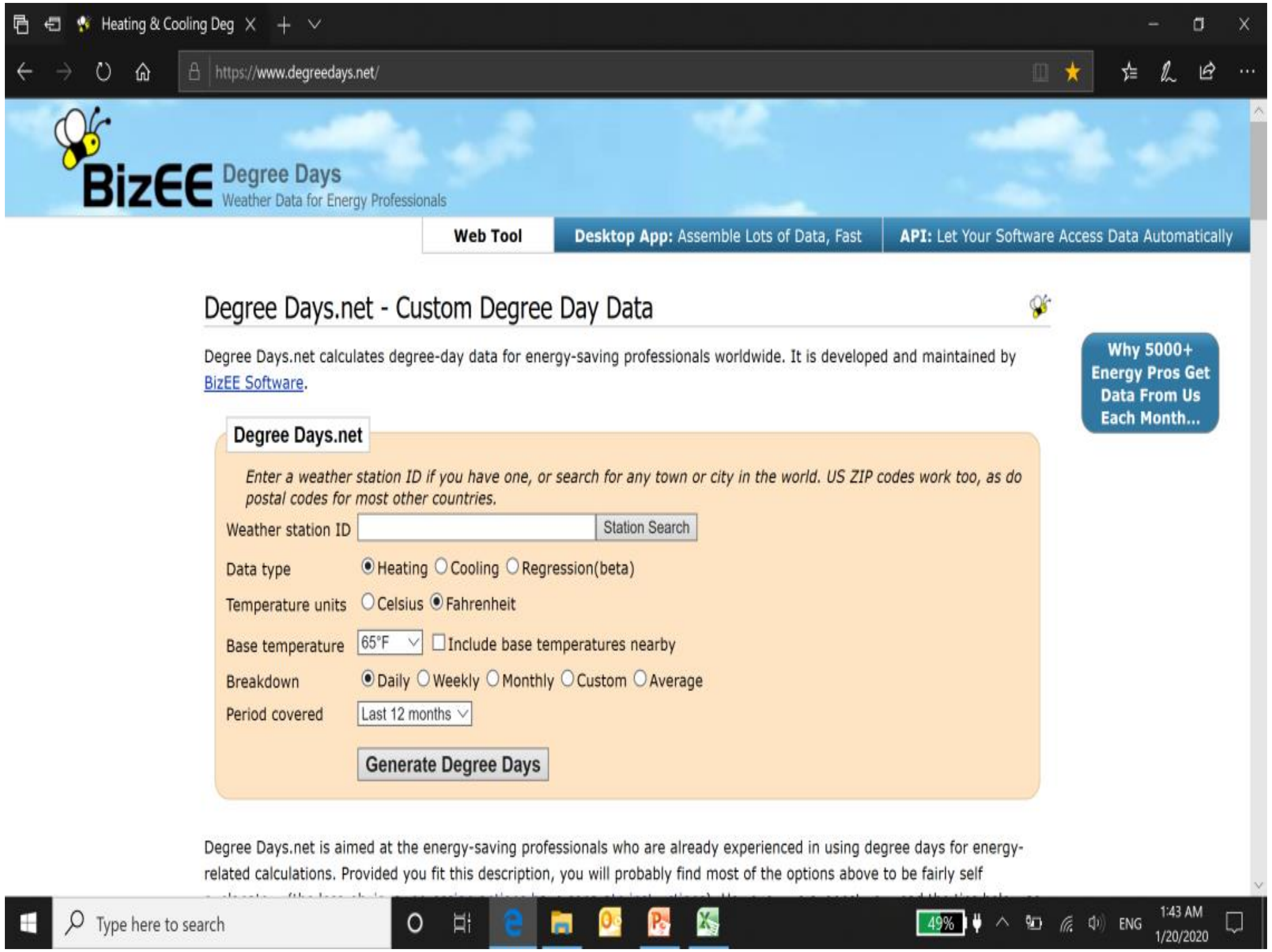
  Because the result is above 24°C

  29.5°C - 24°C = 5.5 Cooling Degree Days

- The high temperature for a particular day was 13°C and the low temperature was 7°C. The temperature mean for that day was:

  (13°C + 7°C) / 2 = 10°C
  Because the result is below 24°C:
  24°C - 10°C = 14 Heating Degree Days

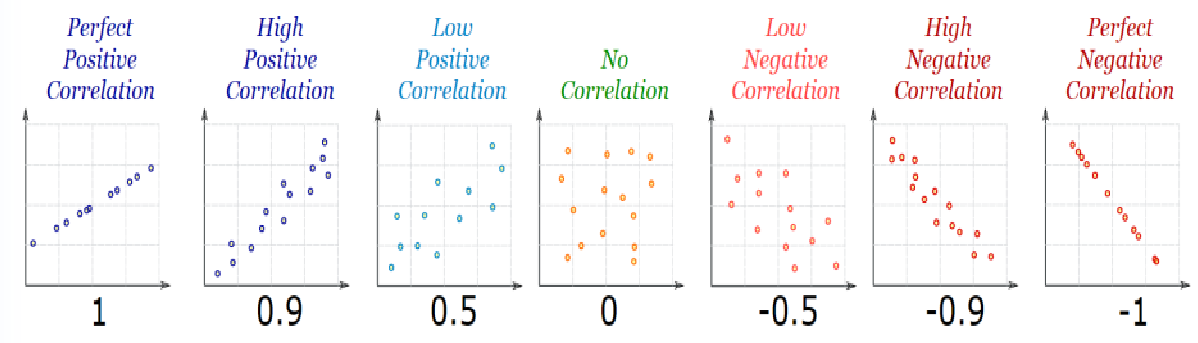
Normalizing the EnPIs



Normalizing the EnPIs

What is Correlation?

- When two sets of data are strongly linked together we say they have a High Correlation.
  - ✓ Correlation is Positive when the values increase together, and
  - ✓ Correlation is Negative when one value decreases as the other increases
- A correlation is assumed to be linear (following a line).



- Correlation can have a value:
  - ✓ 1 is a perfect positive correlation
  - ✓ 0 is no correlation (the values don't seem linked at all)
  - ✓ -1 is a perfect negative correlation

Normalizing the EnPIs

Finding Correlation

- First step is to find out if a variable has significant impact on the energy consumption or not
- Arrange all the variables in excel columns ensuring they have same timeline
- A Correlation Matrix can be created using advanced add-ins like SPC-XL or using the Excel Analysis tools

	Natual Gas Consumption [m3]	*Electricity Consumption [kWh]*	*Monthly Production [tonne]*	*HDD's @15°C*
Natual Gas Consumption [m3]	1			
Electricity Consumption [kWh]	0.302968912	1		
Monthly Production [tonne]	0.247655351	0.964633525	1	
HDD's @15°C	0.81145471	-0.213378671	-0.290101427	1

giz

Normalizing the EnPIs

Regression Analysis

- Next step is to conduct the regression analysis
- The resultant regression formula (Slope) can be used to calculate the future energy consumption based on significant variables

Normalizing the EnPIs

Regression Summary

Regression Statistics	
Multiple R	0.955640108
R Square	0.913248016
Adjusted R Square	0.893969797
Standard Error	10450.77679
Observations	12

Resultant Regression Formula
Energy = a + b x Production + c x HDD

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	10347822609	5173911304	47.37201248	1.66824E-05
Residual	9	982968620.2	109218735.6		
Total	11	11330791229			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
a	Intercept	81099.42339	9569.198139	8.475049028	1.39212E-05	59452.39327	102746.4535	59452.39327	102746.4535
b	Monthly Production [tonne]	61.79912058	12.02015814	5.141290145	0.000610237	34.60763375	88.99060742	34.60763375	88.99060742
c	HDD's @15°C	209.4677494	22.28114615	9.401120929	5.96824E-06	159.064295	259.8712038	159.064295	259.8712038

R = Correlation coefficient

P-value < 0.05 → Significant

R^2 reaching 1 → Significant

Setting Target

- Regression Slope can also be used for forecasting, budget setting, target setting etc.
- E.g. If the target is to reduce energy consumption by 10%; the values of constants shall be reduced by 10% in the regression formula; Energy = a*0.9 + b*0.9*Production + c*0.9*HDD

Individual task

Try regression on data provided in HO 130004

- Test if HDD has significant correlation on Electricity and Gas Consumption
- Conduct Regression Analysis and derive the Slope for Electricity and Gas Consumption
- Present your results in plenary

Time: 30 min

Data requirements for Deep-dive energy assessment

- How detailed data do you gather for energy balance?
  - ✓ Energy sources
  - ✓ Major departments
  - ✓ Machinery / equipment
  - ✓ Generally, at department level and for some significant machines
- Why?

Task – The Textile Company

Develop an energy balance of The Textile Company using provided energy data

Your tasks as a groups are;

- Develop an energy balance of The Textile Company using provided energy data
- Update Material/Energy Flow Charts with energy values
- Is any data missing or incorrect?
- Identify Significant Energy Uses (SEUs)
- Calculate Energy Baseline values
- Enlist significant variables for SEUs
- Present your results in plenary

Time: 90 min

Key takeaways

- A systematic approach must be adopted in prioritizing areas of attention. This can be achieved by identification of Significant Energy Uses (or energy intensive processes or operations as mentioned in Higg FEM) and develop performance baselines and targets for the same
- EnPIs can be Absolute or Normalized depending on complexity of energy mix or the energy use. It is important to identify variables that significantly effect energy performance and quantify its impact.

giz

Plan next steps

- Develop energy balance with quantities and costs
- Identify significant energy uses (SEUs) and their contribution to the energy consumption and cost
- Identify which variables significantly affect which of the SEUs and their EnPIs and decide between Absolute and Normalized EnPIs
- Develop baselines and improvement targets

giz

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH