

# Green ICT metrics and Biomimicry

Presented by  
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# Agenda

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# Motivation

- Sustainability needs to be pushed at all levels of ICT lifecycle.
- The main method to do this at the usage phase is to decrease(optimize) the usage itself.
- Network measurements can help in optimizing the usage of an ICT system.

# Subject of work

- Current green network metrics;
- Relation of those metrics to the sustainability problem;
- Consequently, an analysis of a sustainable framework for ICT systems assessment.

# Methodology

- First, metrics have to be found
  - Keywords: metric, green IT, green ICT, probably more.  
Google scholar, [greenit-conferences.org](http://greenit-conferences.org)
- Metrics are classified on their contribution and related to a sustainability problem in a systematic way

# Current metrics found (1)

- 25 metrics found across 12 white papers and scientific articles ranging from Oct. 2007 to May 2015;
- 11 of them are developed by the Green Grid;
- Most of them deal with energy-related issues, however some are elaborating on other aspects.

# Current metrics found (2)

- DCeP, DC Energy Productivity

$$DCeP = \frac{\text{Useful Work Produced}}{\text{Total Energy Consumed Producing this Work}}$$

- WUE, Water Usage Effectiveness

$$WUE = \frac{\text{Annual Site Water Usage}}{\text{IT Equipment Energy}}$$

- VM-PUE [1], VM Power Usage Eff.

$$VM-PUE_{ik} = \frac{P_{ik}}{\sum_j P_{ijk}}$$

- Recyclability KPI [2]

$$\Gamma = \frac{\sum_{i \in \bar{X}_r} \rho_i}{|\bar{X}_r|}$$

# Problem of metric classification for sustainability

- ICT is a complex system; sustainability imposes multiple constraints.
- No framework for sustainability assessment within ICT is existing. Hence, a proper methodology is required.
- A concept of Biomimicry can provide one.

# Biomimicry

Proposed by Janine Benyus in 1997 [3]; proposes the ways on how to benefit in sustainability from adopting nature's rules.



Image courtesy of Biomimicry 3.8

# Approach 1 - Ten commandments (1)

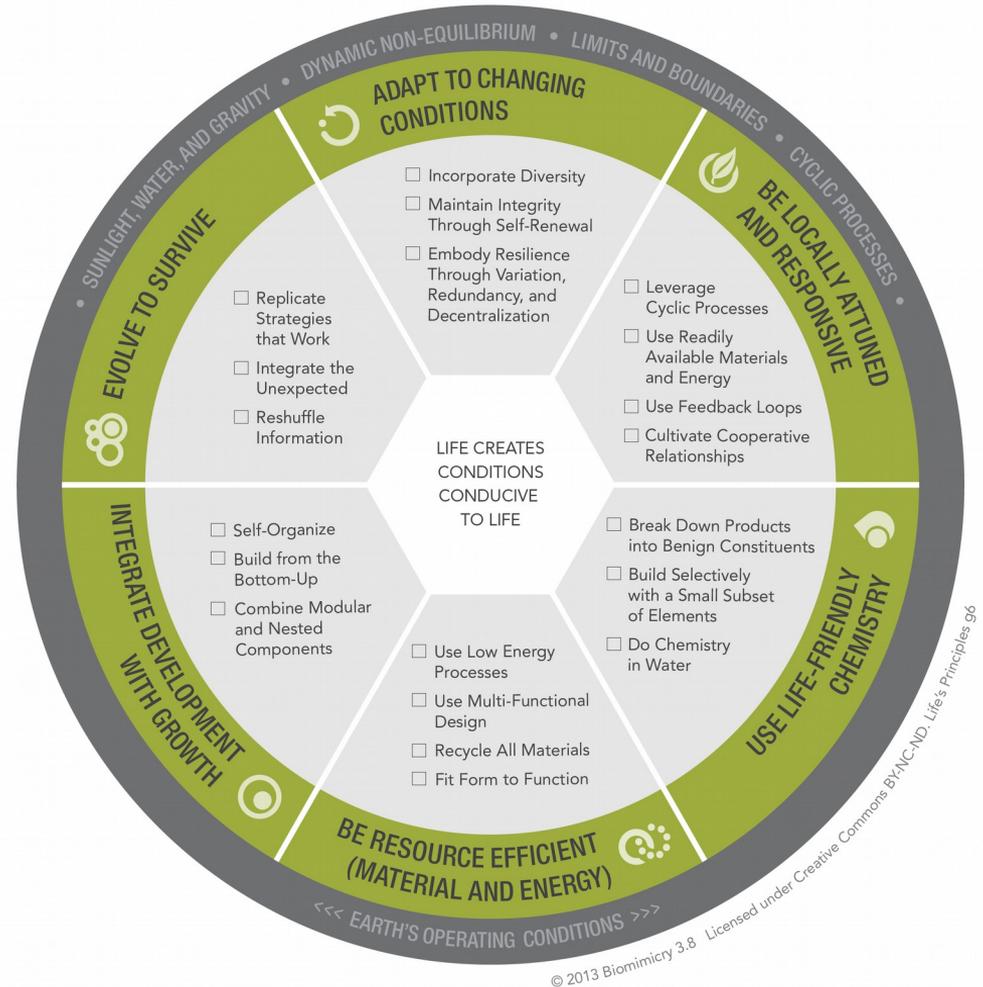
1. use waste as a resource,
2. diversify and cooperate to fully use the habitat,
3. gather and use energy efficiently,
4. optimize rather than maximize,
5. use materials sparingly,
6. don't foul their nests,
7. don't draw down resources,
8. remain in balance with the biosphere,
9. run on information,
10. shop locally.

# Approach 1 - Ten commandments (2)

1. use waste as a resource – related to recycling, so we can consider such metrics to be associated with this commandment;
2. diversify and cooperate to fully use the habitat,
3. gather and use energy efficiently – indeed, dealing with the energy issues;
4. optimize rather than maximize,
5. use materials sparingly,
6. don't foul their nests – this is about polluting the environment, e.g. gases emissions, radio emissions etc.
7. don't draw down resources,
8. remain in balance with the biosphere – ???
9. run on information,
10. shop locally.

# Approach 2 - Design Lens (1)

- Ten commandments are too broad and fuzzy
- A more specific requirements are needed



# Potential issues and blank spaces?

	Adapt to changing conditions	Be locally attuned and responsive	Use life-friendly chemistry	Be resource efficient	Integrate development with growth	Evolve to survive
use waste as a resource				+		
diversify and cooperate to fully use the habitat	+	+				
gather and use energy efficiently				+		
optimize rather than maximize	+	+	+	+	+	+
use materials sparingly				+		
don't foul their nests		?				
don't draw down resources				+		
remain in balance with the biosphere	+					
run on information		+				
shop locally		+				

# Relation to the ten commandments

	use waste as a resource	diversify and cooperate to fully use of the habitat	gather and use energy efficiently	optimize rather than maximize	use materials sparingly	don't foul their nests	don't draw down resources	remain in balance with the biosphere	run on information	shop locally
PUE (1)			+							
DCiE (2)			+							
CUE (3)						+				
WUE (4)					+					
...										
DCeP (9)			+							
...										
VM-PUE <sub>ik</sub> (16)			+							
...										
$\Phi$ (24)						+	+			

# Implementation of the ten commandments in current green metrics

Completed commandments are highlighted:

use waste as a resource  
use materials sparingly  
don't foul their nests  
run on information  
shop locally

diversify and cooperate to fully use the habitat  
gather and use energy efficiently  
optimize rather than maximize  
don't draw down resources  
remain in balance with the biosphere

# Implementation of Design Lens aspects by current green metrics

Implemented aspects are highlighted:

Adapt to changing conditions

Be locally attuned and responsive

Use life-friendly chemistry

Evolve to survive

Be resource efficient

Integrate development with growth

# Conclusions on green metrics

- Quite some green metrics already exist, so development of new ones is quite complicated.
- Current green metrics are only covering a fraction of the Biomimicry framework → other methods are required to push sustainability in ICT.

# Conclusions on Biomimicry as a framework

- Ten commandments and Design Lens are slightly different and are not “overlapping”.
- Non of the two are perfect for ICT in terms of aspects covered.
- In general, Biomimicry seems to be quite suitable for sustainable ICT in case if a more profound methodology is being introduced.

# Future work and application

- Better Biomimicry framework is required – incorporating advantages of the ten commandments and the Design Lens plus ethical issues.
- This work can be potentially implemented in a control mechanism for “green” networks; for instance, in an SDN control plane.

# Thank you!

References used in the slides:

- [1] C. Cappiello, S. Datre, M. Fugini, P. Melia, B. Pernici, P. Plebani, M. Gienger and A. Tenschert, "Monitoring and assessing energy consumption and CO2 emissions in cloud-based systems," in Proceedings of the 2013 IEEE International Conference on Systems, Man, and Cybernetics, 2013, pp. 127-132.
- [2] N. Drouant, É. Rondeau, J. Georges and F. Lepage, "Designing green network architectures using the ten commandments for a mature ecosystem," *Comput. Commun.*, vol. 42, pp. 38-46 2014.
- [3] J.M. Benyus, "Biomimicry: Innovation inspired by nature": William Morrow New York, 1997