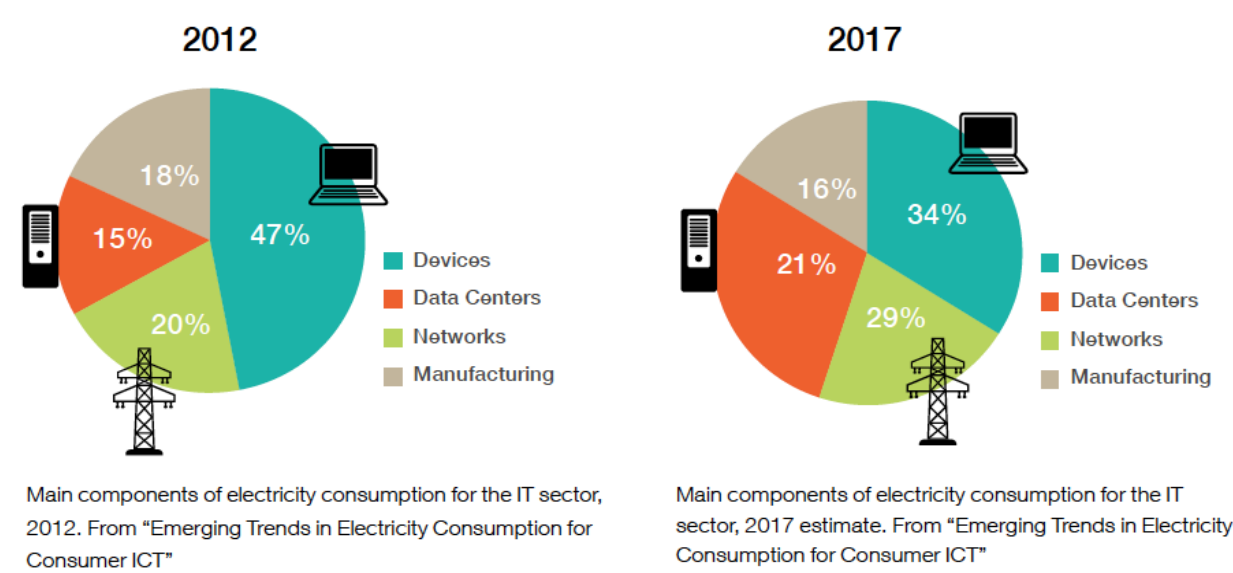


## Data Centers Energy Consumption

Data Centres play an increasingly important role in society, as more and more ICT services and applications are being developed. This has a strong impact on the Energy sector: **the rapid rise of energy-hungry Data Centres means a significant growth in power consumption and electricity usage.**



**Main components of electricity consumption for the ICT sector (Ref: Greenpeace Report, May 2015)**

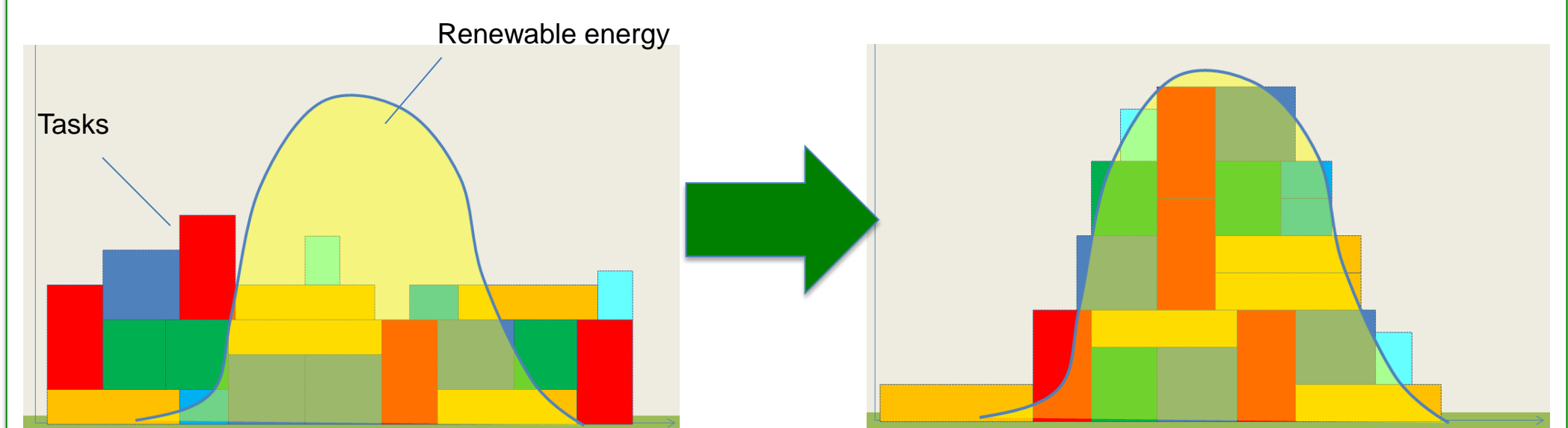
The growing power demand of DCs has naturally led to a heightened awareness of their increasing impact on climate change from greenhouse gas (GHG) emissions.

## Challenges in DC4Cities

In order to tackle the problem of Energy consumption in Data Centres, efforts were made primarily in developing more energy efficient processors and/or computing environments.

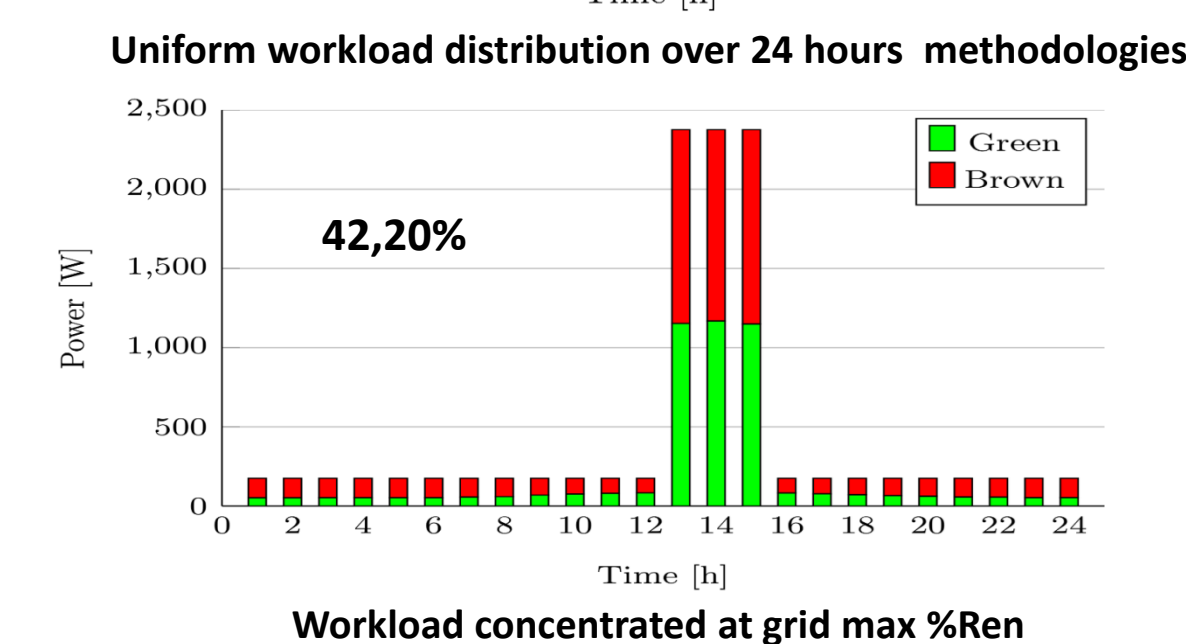
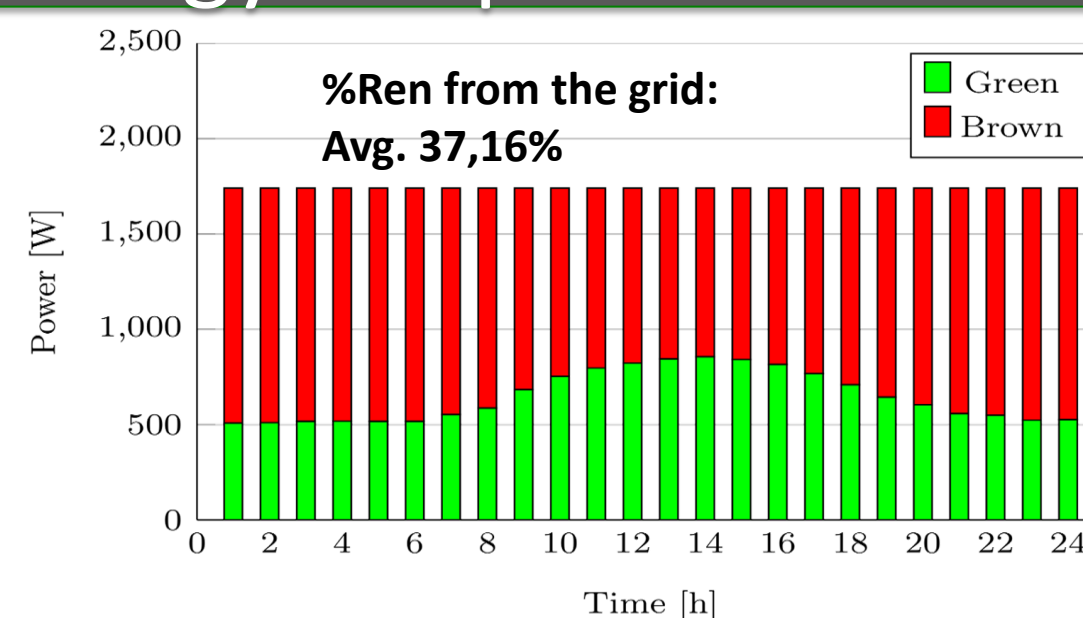
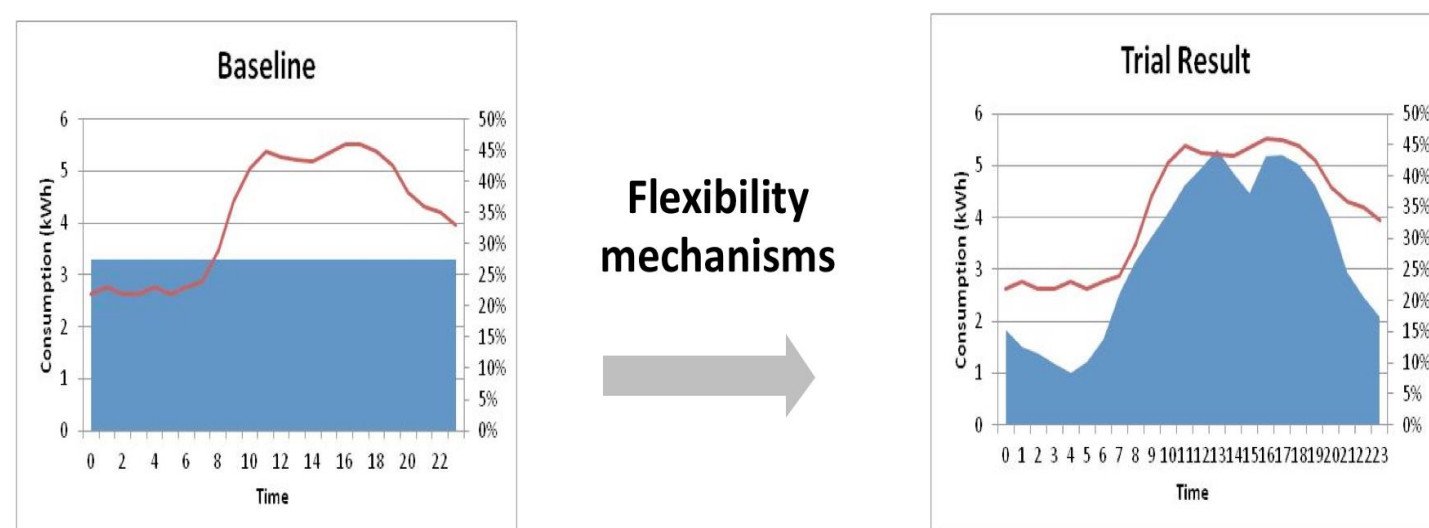
**DC4Cities wants to do more, reshaping the way energy is consumed in a Data Centre.**

DC4Cities wants to make IT workloads become **energy adaptive** with the ultimate goal of maximizing the renewable energies share in the used electricity mix, hence adapting the workload – and therefore power consumption - to the volatile availability of renewable energy. DC4Cities is developing a wide array of **technology components** at different levels in order to achieve this goal.

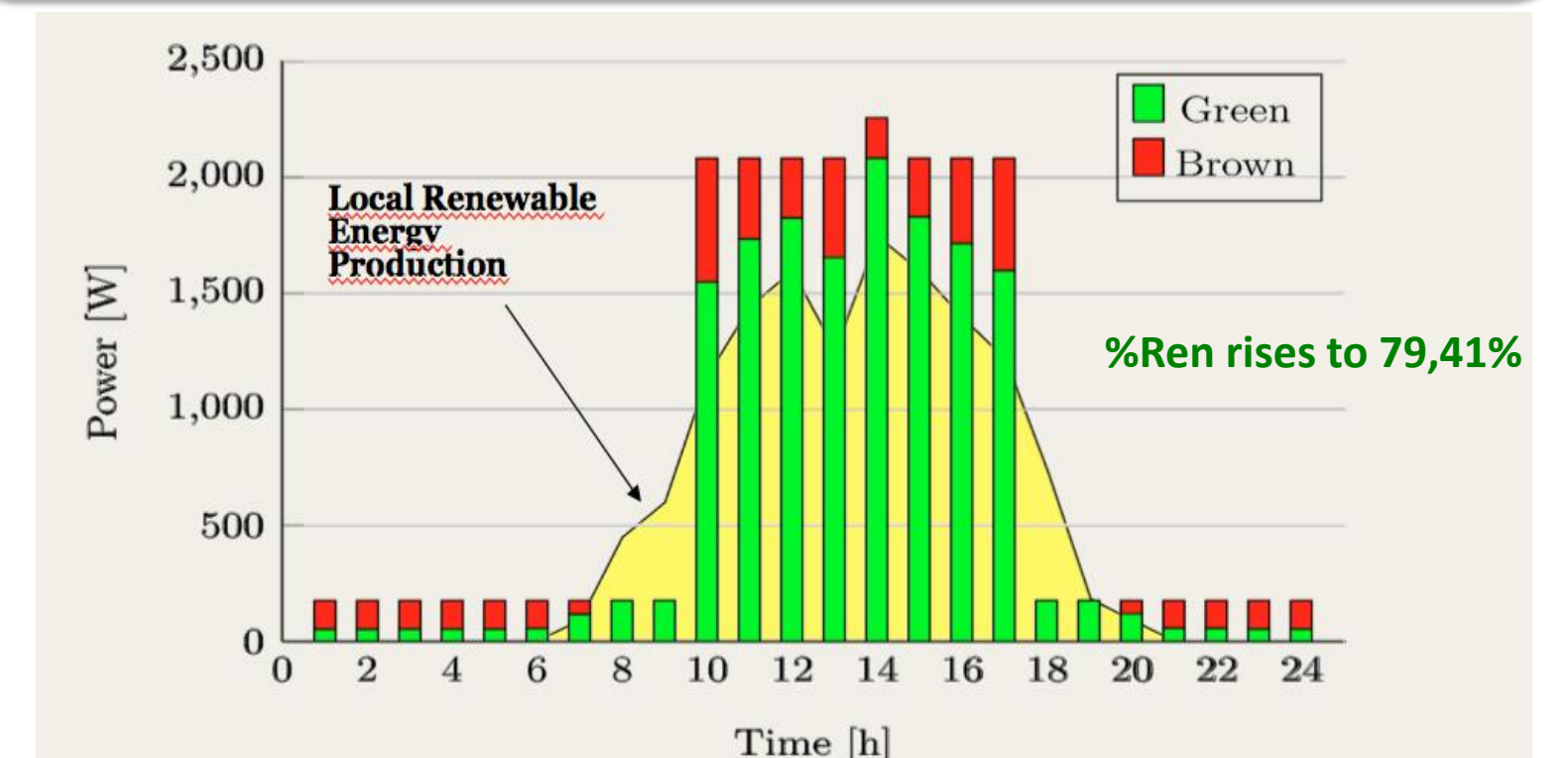


## Data Center Energy Adaptation: DC4Cities project results

**Flexibility mechanism:** to increase the percentage of renewable energies usage through the implementation of technologies to manage the energy consumption by means of shifting/tuning the workload to those periods of time when more renewable sources are available.



A new concept of energy-adaptive planning was developed and put in place.  
Trials were carried out on the new technologies in **TRENTO, BARCELONA, MILAN**



## DC4Cities: New Metrics

The project is developing a new set of metrics. Some examples:

Parameter	Metric
% of renewables	RenPercent
Flexibility	Datacentre Adapt (DCA), Adaptability Power Curve (APC)
Environmental impact	PE_Savings, CO2_Savings
Economic impact	Economic Energy Savings

DC4Cities project is leading the **Smart City Cluster** collaboration with other 8 EU projects

Activities on metrics, developed within the project and in the Cluster, are being presented to **Standardization Bodies** for discussion and follow-ups

**DCeP:** this metric is proposed to compute the ratio of energy resources consumed to useful work in a data centre. It takes into account all the main factors, but it is exceedingly difficult to be calculated in practice.

$$DCeP = \frac{\text{Useful work produced}}{\text{Total energy consumed by the data center}} = \frac{\sum [V_i \cdot U_i(t, T) \cdot T_i]}{E_{DC}}$$

How to calculate mathematically the "useful work" performed by a DC?

It is particularly complicated because it depends on the applications/services

A possible simplification: Benchmarks procedure

**Benchmarks procedure in ENEA experimental campaign:** a set of experiments were carried out to understand and measure the relationship between work performed and power spent, both in real web-server architectures (e.g: Apache JMeter, Nginx), and in simulated environments set up with specific applications (e.g: Filebench). The 2 situations were then compared in order to gain insight on general factors affecting energy consumption.

