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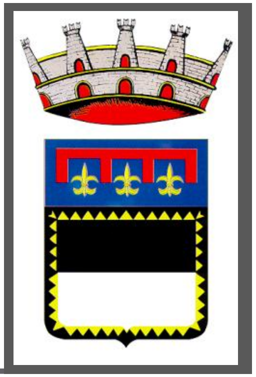
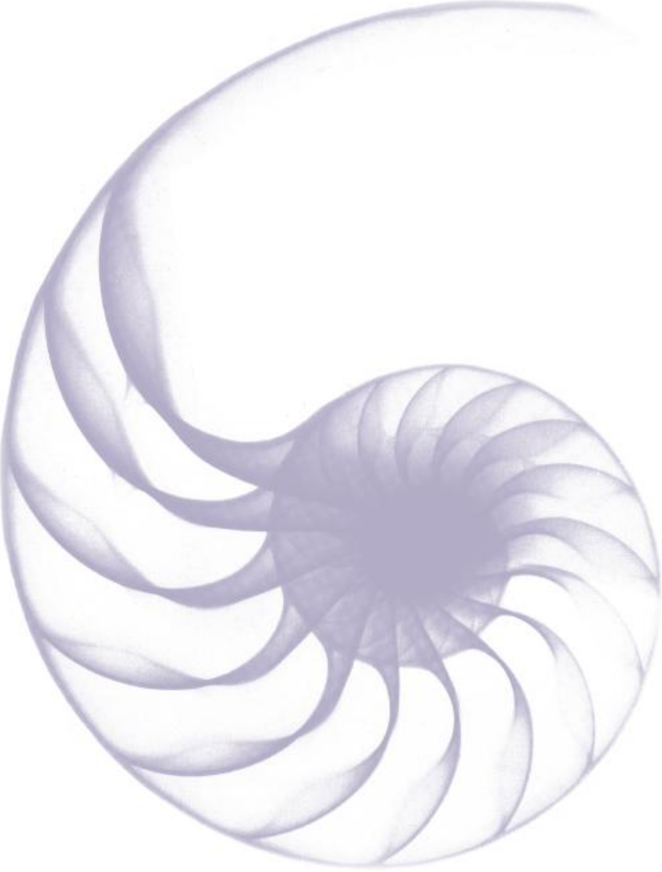
IDEE, PROGETTI E SOLUZIONI.

BUILDING THE SEAP OF CESENA



6 May 2011



Green Energy 2011

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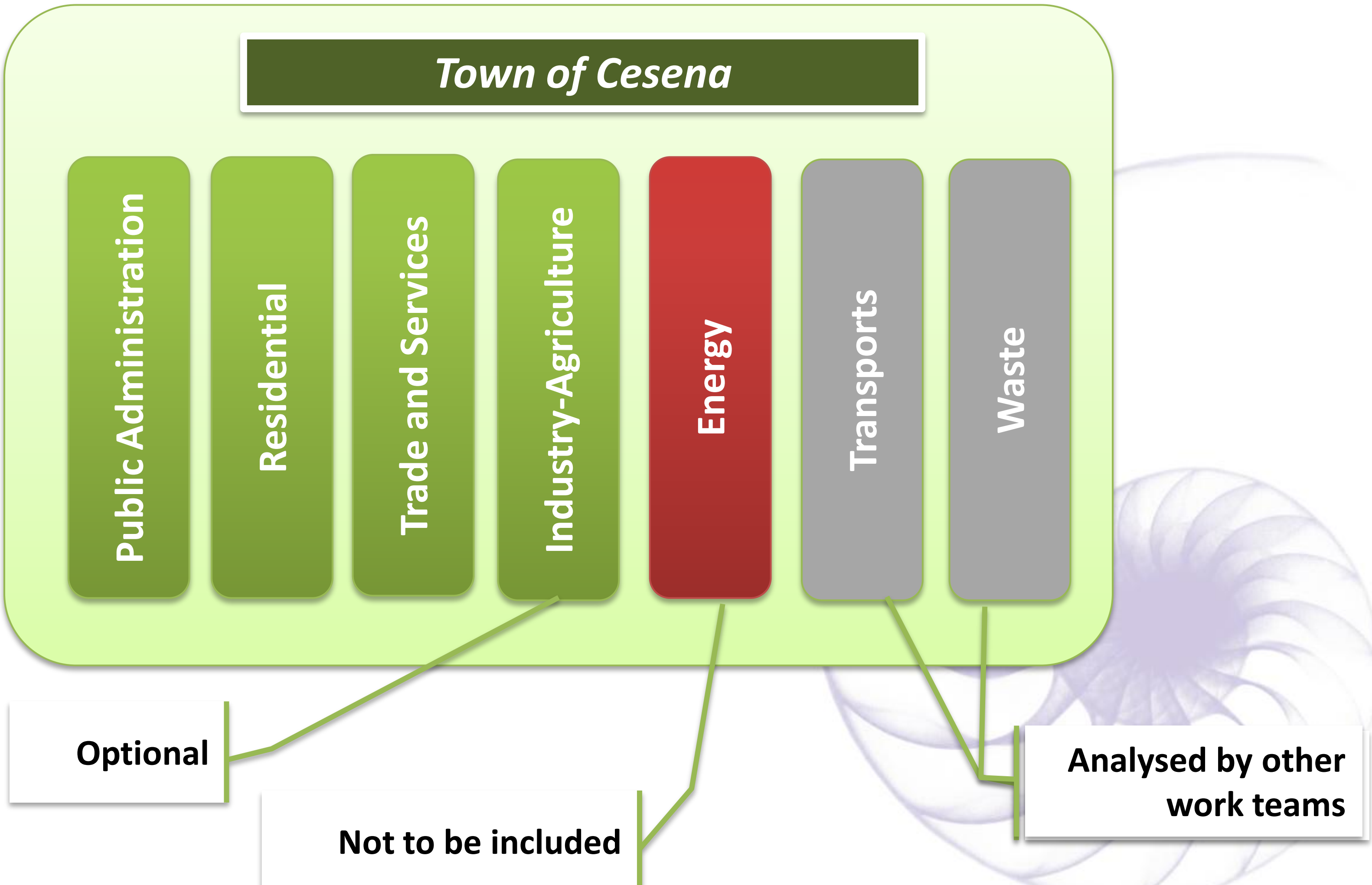
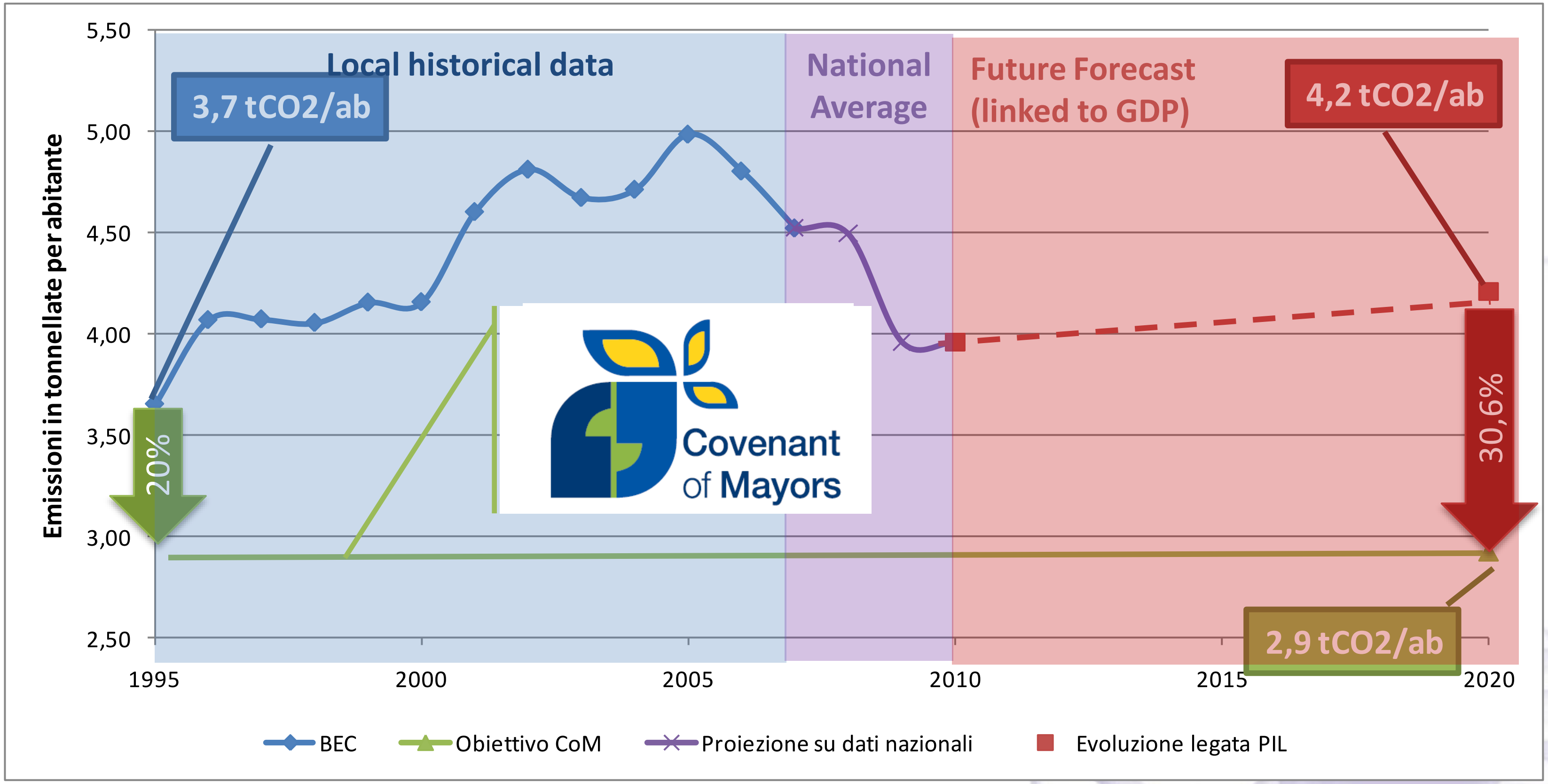
- Scope and Objectives
- Evaluation Methodology
- Building the Reference Scenario
- Governance and Monitoring
- Conclusions

First: Define the Scope

Scope and Objectives



Scope and Objectives



Objective: reduce per-capita emissions down to **2.9 tons** (20% less than in 1995, our Reference Year); this is equivalent to an absolute reduction of over **130 thousand tons of CO2 equivalent** (assuming 101 thousand inhabitants in 2020)

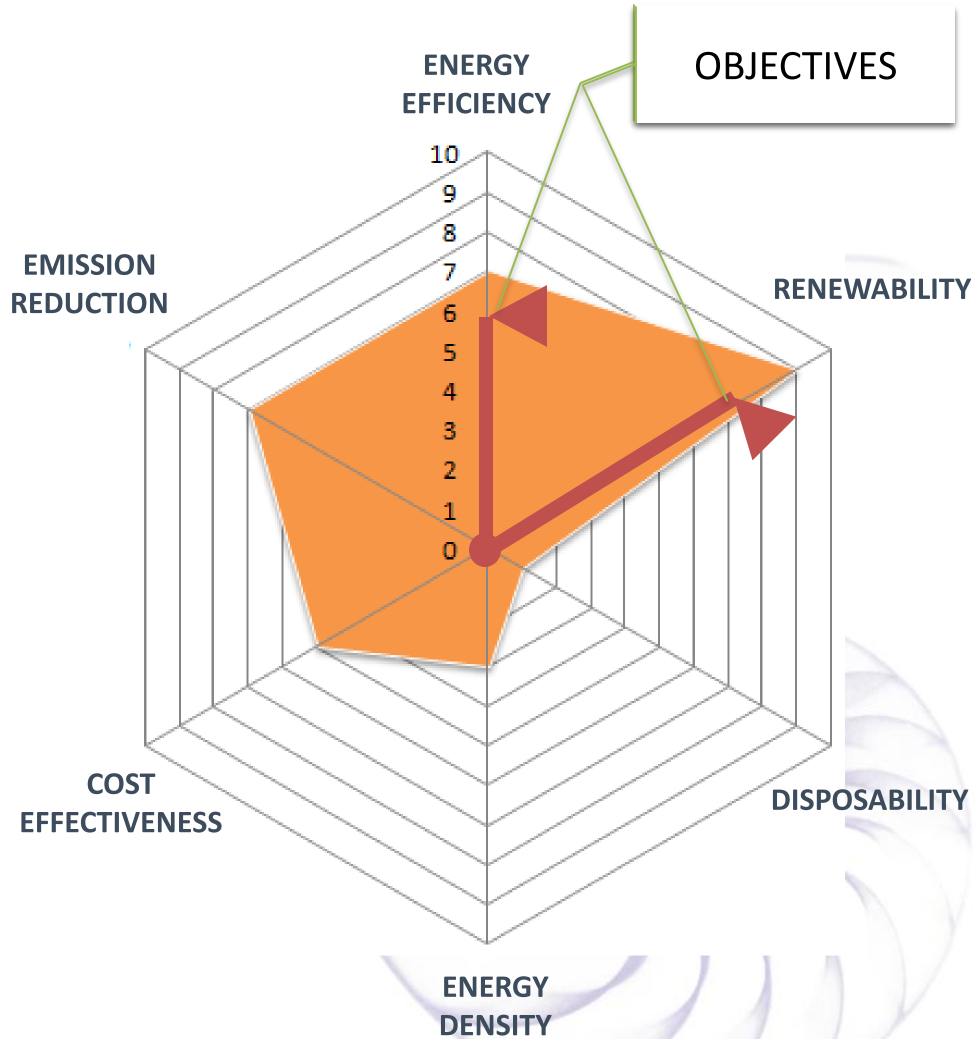
How to Evaluate an Energy System?

- From a scientific point of view, the dividing line goes between qualitative and quantitative impact statements
- **The translation into a single unit**, e.g. monetary values or CO2 emission savings, however it is done, **is losing part of the message** and may not allow a fair assessment
- It is better to use an **impact profile**: each type of impact is evaluated in its own units, but in the same way for every energy system, so that it tells the decision-maker where two energy systems actually differ from each other
- In order **to choose** between two alternative energy systems performing in different ways over the defined set of impacts, **the decision-maker must assign weights to different kinds of impacts** (e.g. comparing greenhouse warming impacts of fossil systems with noise and visual impacts of wind turbines)
- The assignment of weights to different impact categories is the **central political input into the decision process**

A 6-fold Impact Profile

Evaluation Methodology

- Our methodology is based on impact profiles made of 6 evaluation indicators
- Each indicator is evaluated in its own units, but a final re-scaling on a [0-10] score axis is performed in order to allow an easier comparison
- The decision maker is presented with a radar diagram, the shape of which is related to the characteristics of the energy system
- We can set numeric objectives on each axis of the diagram and easily spot whether they are achieved or not



Evaluation Indicators

Energy efficiency	• Primary energy saved, compared to the global primary energy consumed in the BAU scenario
Renewability	• Renewable primary energy production, compared to the global primary energy consumed
Emission Reduction	• Percentage of CO2 reduction with respect to the global emissions in the BAU scenario
Energy density	• Ratio between the energy produced or saved and the required area (it measures the land extension required by the energy system)
Disposability	• Estimate of the ease of disposal of the energy infrastructure at the end of life (hazards, method of disposal, recycling opportunities, …)
Cost Effectiveness	• Ratio between the emission saved and the monetary costs

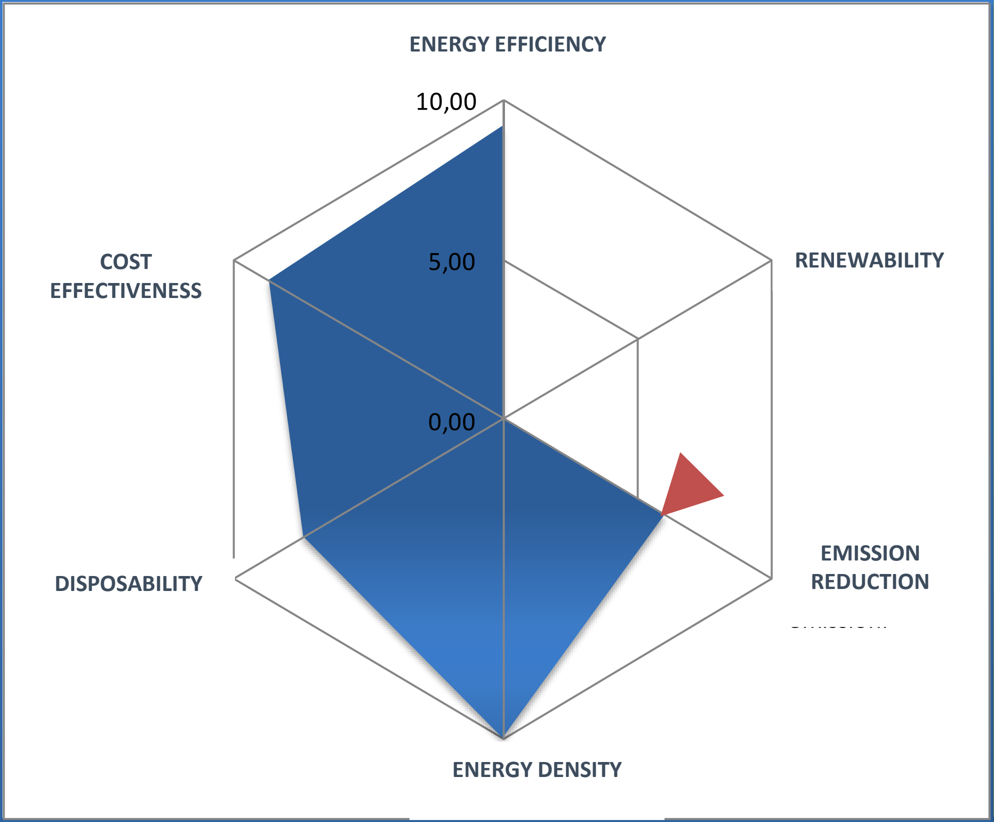
Evaluation Indicators /2

Evaluation Methodology

INDICATOR	Formula	Unit
Energy efficiency	$\frac{Primary\ energy\ amount\ saved\ (tep)}{Global\ energy\ consume\ (tep)}$	%
Renewability	$\frac{Primary\ energy\ amount\ produced\ through\ renewable\ sources\ (tep)}{Global\ energy\ consume\ (tep)}$	%
Emission reduction	$\frac{Emission\ reduction\ amount\ (tCO2)}{Global\ emission\ (tCO2)}$	%
Energy density	$\frac{Energy\ produced\ or\ saved\ amount}{Size}$	toe/m^2
Disposability	$\sum_{weighted} Environmental\ impact, hazard, recycle\ and\ life\ cicle$	Score [0..10]
Cost effectiveness	$\frac{Emission\ reduction\ amount\ (tCO2)}{Global\ cost}$	tCO2/ M€

SINGLE TECHNIQUE EVALUATION - COGENERATION

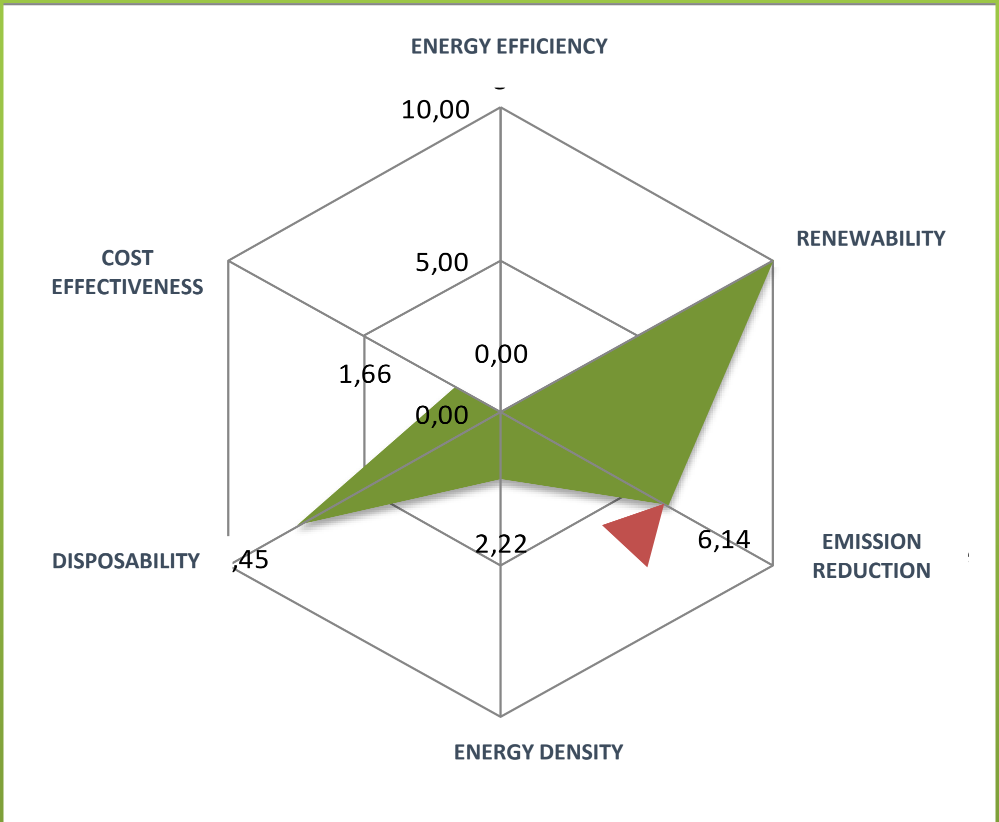
Evaluation Methodology



- Combined generation of electricity and heat from fossil fuels (mainly methane gas)
- It is fundamentally a technique improving the generation efficiency, therefore it shows a high score on the Energy Efficiency axis
- Because the primary energy source is a fossil fuel
  - The Renewability score is 0
  - The Energy Density is quite good
- The underlying technology is mature, therefore the Cost-effectiveness is also good

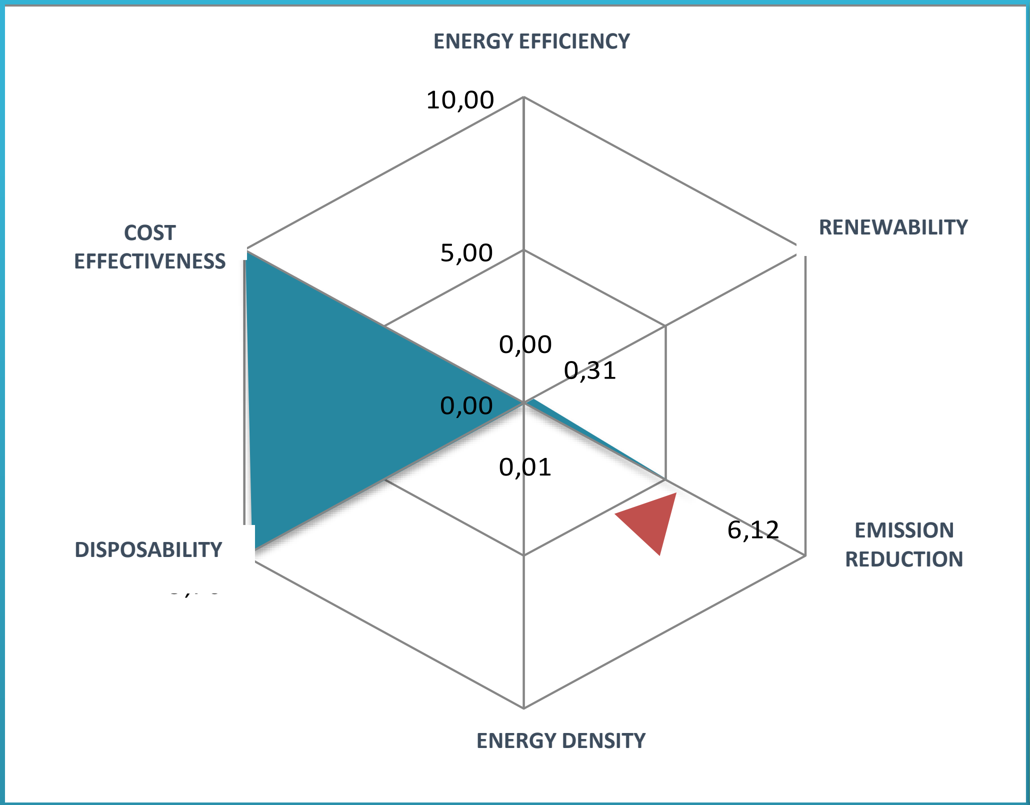
Single Technique Evaluation – Solar PV

Evaluation Methodology



- Solar PV rely on a totally renewable primary energy source, therefore it achieves the maximum score on the Renewability axis
- The Energy Efficiency score is 0, because there's no net energy saving
- Powerful technique for Emission Reduction, because Italy's emission factors for electricity generation are relatively high
- The technology of standard PV panels is quite mature, although it is still relatively expensive (public incentives not considered)
- As many other renewable energy systems, it suffers from relatively low Energy Density

SINGLE TECHNIQUE EVALUATION – FORESTED AREAS

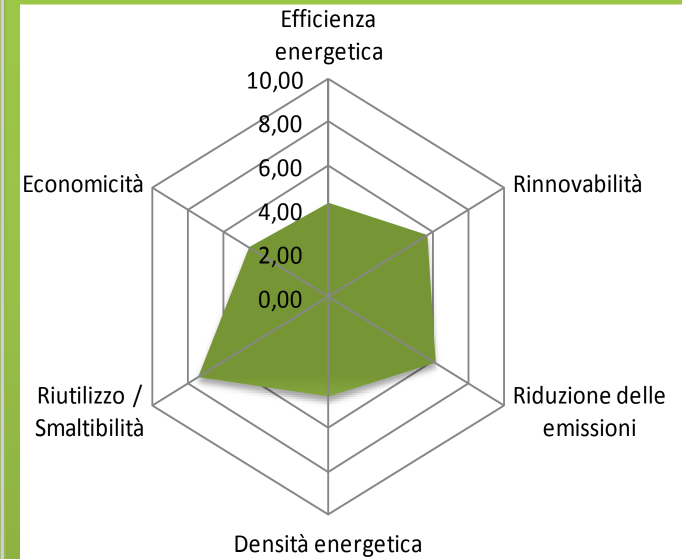


- Reforestation is a peculiar technique of emission reduction, as it does not generate nor save energy, but it can reduce atmospheric CO_2 by phytomass absorption
- Energy Efficiency and Renewability indicators will be 0 because no net energy is generated nor saved
- Energy Density is measured as the energy content of the produced phytomass, and is very low
- It is very cost-effective per unit of CO_2 absorbed, and of course Disposability has the highest score

Evaluation of entire Scenarios

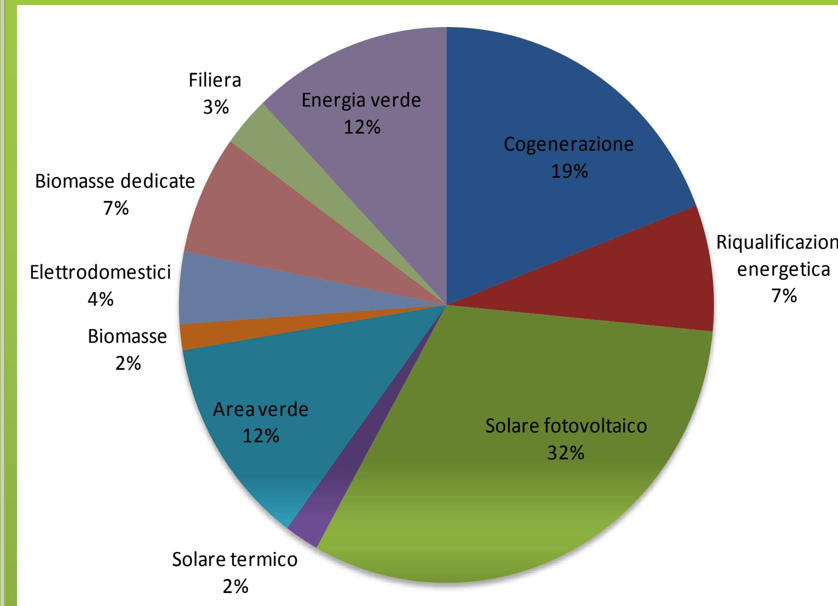
Evaluation Methodology

EVALUATION



Energy efficiency	4,30
Renewability	5,45
Emission reduction (*)	6,02
Energy density	3,99
Disposability	7,31
Cost effectiveness	4,95

COMPOSOTION (AS % OF CO2 REDUCTION POTENTIAL)



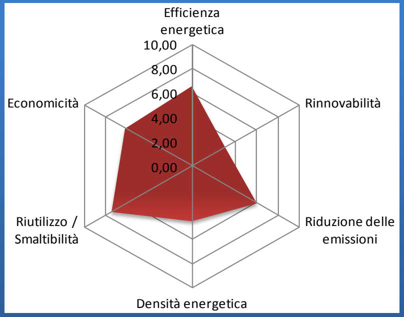
- **Renewable generation** has the highest share: solar, biomass and green electricity account for 57% of expected emission reduction
- **Energy Efficiency**, notably co-generation and district-heating, is also very important (33%)
- **CO2 absorption sinks** through reforestation play a non negligible role (12%)

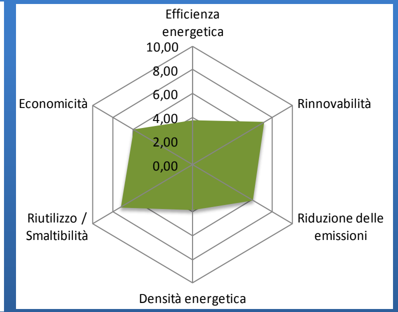
Comparison of different Scenarios

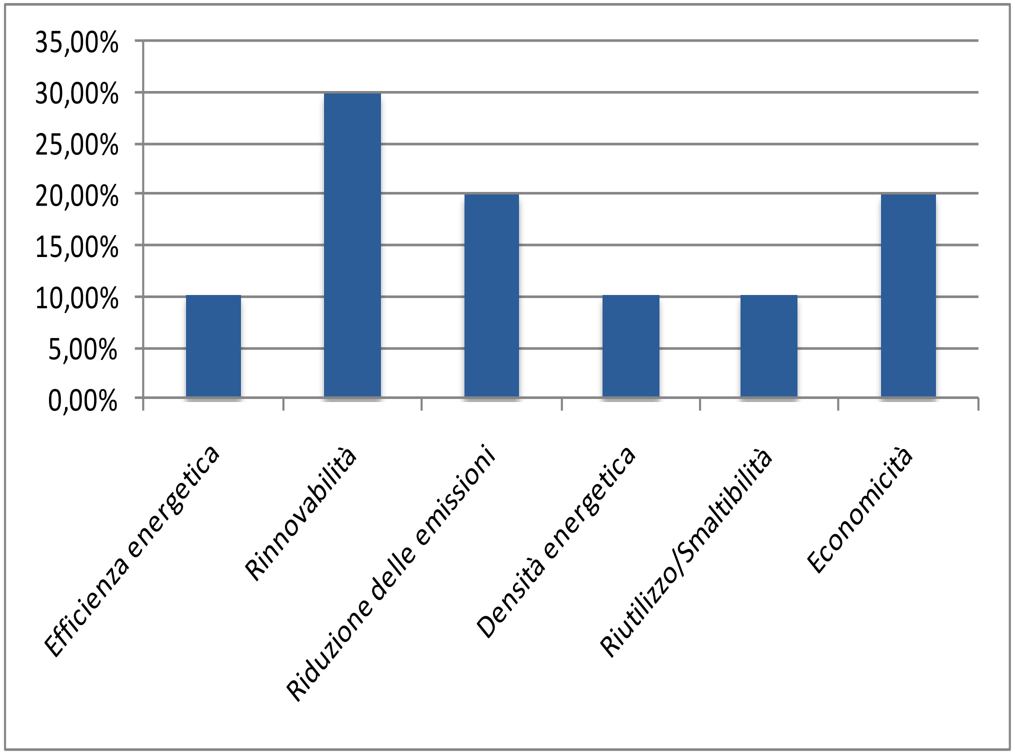
Evaluation Methodology

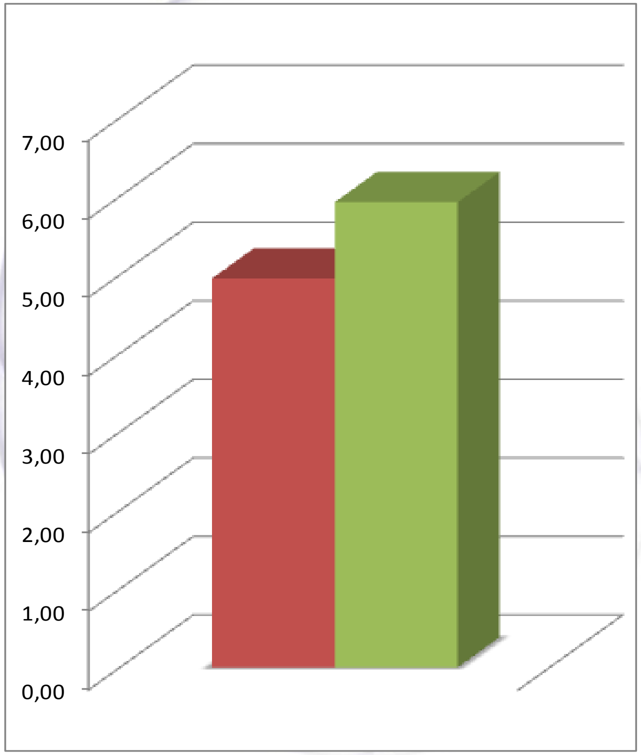
Scenario 1 vs Scenario 2

Process of decision making based on the assignment of weights to the evaluation indicators









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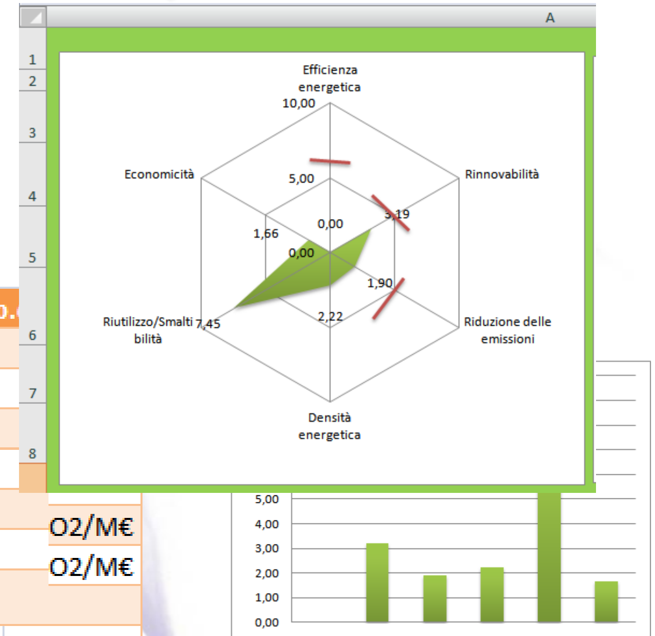
Evaluation Methodology

Indicatore di dettaglio	Valore	Unità globale	Unità p.c.
Produzione elettrica	126	kWh/mq*anno	kWh/mq*anno
Area residenziale del comune	1.698.953	mq	mq
Area industriale del comune	1.698.953	mq	mq
Area pannellabile residenziale	20%		
Area pannellabile industriale	20%		
Area pannellabile del comune	679.581	mq	mq
Producibilità totale	0,846	GWh(e)	MWh(e)/ab
Consumo totale Comune di Cesena	2,30	ktep	tep/ab
Quota rinnovabile BAU 2020	9,04%		
Indice quota rinnovabile		**3,19**	

Indice riduzione emissioni	**1,90**
Indice economico	**1,66**



A parametric tool has been developed to evaluate alternative energy systems and tune the Reference Scenario according to the inevitable changes in the external context over the 10-year span of the Energy Plan

The tool can be integrated with a monitoring software to give the Town Energy Manager a valuable governance tool

How to Build a Reference Scenario

- Short-list possible solutions
- Evaluate absolute potential and scalability of each one, relying only on technical (i.e. non-market, non-political, non-contextualized) inputs
- Build different scenarios achieving the same primary objective of emission reduction
- Compare them by assigning political weight to the 6 evaluation indicators
- Select a “candidate scenario”
- Perform an accurate reality check with respect to the local context (market trends, social and economic situation, available resources, public incentives, etc.)
- Tune the candidate scenario to obtain the Reference Scenario

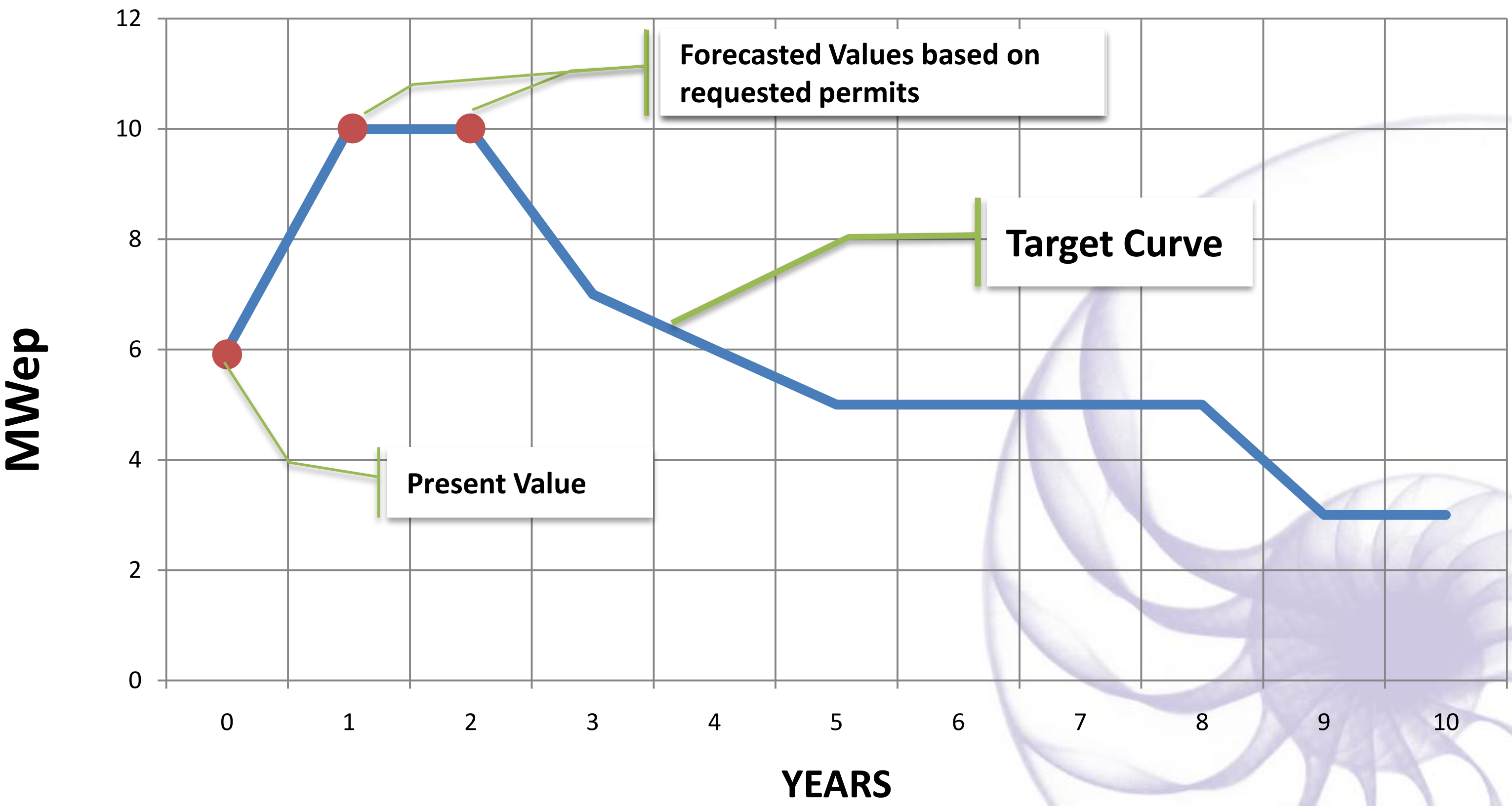
Building the Reference Scenario

Reference Scenario(2020)	
Solution	**Description**
Reforestation	**1,6 km^2** reforested area
Waste biomass	Combined electricity and heat production of **7 GWh_t** and **5 Gwh_e** from waste biomass
Energy efficiency of house appliances	**11 GWh_e** yearly savings by improving the energy class and the finale use of house appliances
Co-generation	Co-generation plants and district-heating networks producing **146 GWh_t** and **102 Gwh_e** per year
Building sector	Improving the energy performance of **18%** of residential building surface (from E to **C energy class**) and building **new class A or B houses**
Solar PV	Solar PV plants for **61 MW_ep** , deployed preferably on roof tops and parking lots
Solar thermal	Solar thermal panels (mainly residential) for **8,2 MW_tp**
Energy crops	**5 km^2** land area (not used for food production) dedicated to the cultivation of energy crops to produce combined electricity (**13 GWh_e**) and heat (**16 GWh_t**)
Energy efficiency in the industry	Better **(6%)** energy efficiency of industrial processes could save yearly **8 GWh_e**
Green electricity	Procurement of green electricity for **32 Gwh_e** per year

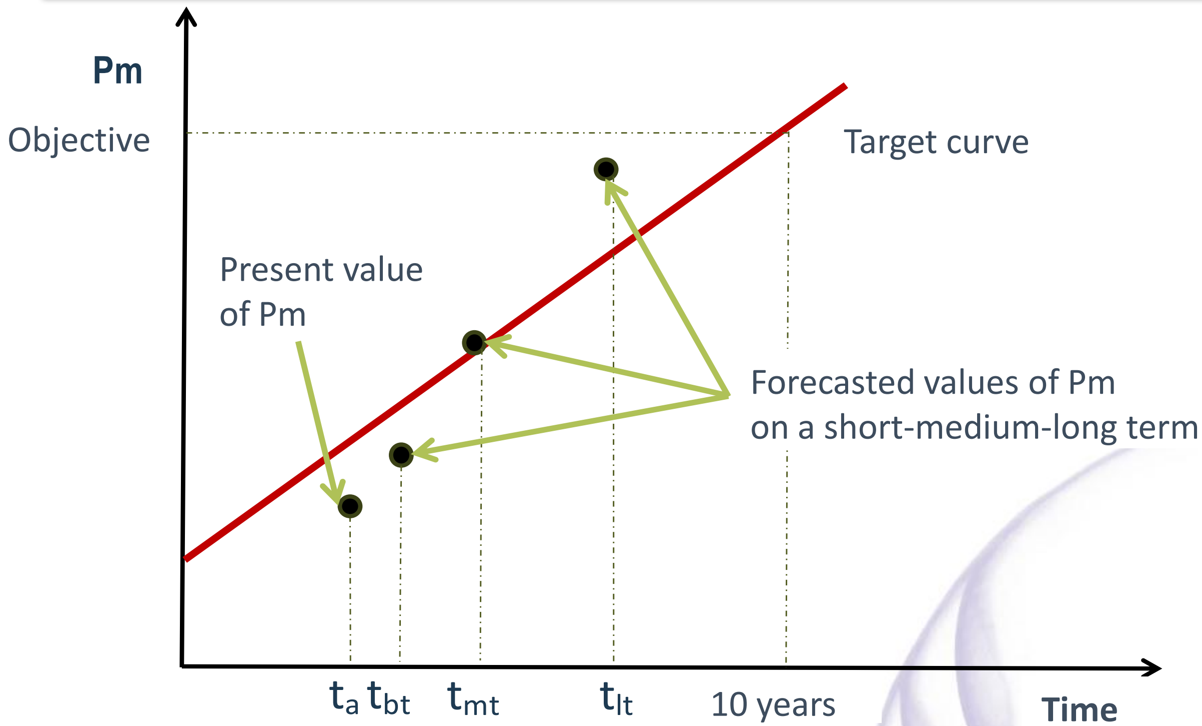
Define Monitoring Parameters

Solution	Monitoring Parameters (Pm)
Co-generation	Number of co-generation plants deployed, peak thermal power, plant load factor Extension of district heating network
Building sector	Renovated building surface, energy class
Waste biomass	Weight of collected dry biomass; number of co-generation plants deployed, peak thermal power, plant load factor
Energy crops	Cultivated area; weight of collected dry biomass; number of co-generation plants deployed, peak thermal power, plant load factor
Solar PV	Number of PV plants and corresponding peak power deployed
Solar thermal	Number of solar thermal plants and corresponding peak power deployed
Forested areas	Reforested land extension
Energy efficiency of house appliances	Electricity consumption of residential sector
Energy efficiency in the industry	Electricity consumption of industrial sector
Green electricity	Total green electricity acquired in the relevant timeframe

Example: Solar PV planned deployment rate



MONITORING PROCESS



Measured and forecasted values in line with the target curve

- No change required

Measured and forecasted values higher (on weighted average) than the target curve

- The Energy Manager autonomously modifies the target curve increasing the short term values and decrerasing the long term ones, so as to maintain fixed the final objective

Measured and forecasted values lower (on weighted average) than the target curve

- The Energy Manager asks the subject matter experts to modify the target curve; if the final objective cannot be reasonably maintained, the structure of the entire Reference Scenario must be modified

MAIN ACHIEVEMENTS

Innovative Evaluation Methodology

- 6-indicator impact profiles to evaluate alternative energy systems with the aim of providing the decision makers with the richest set of data
- Definition of an easy-to-compare score matrix

Consistent Monitoring Process

- Definition of a monitoring process that takes into account historic as well as forecasted data to provide better guidance to the Energy Manager
- The monitoring process can be integrated with the evaluation methodology to provide a powerful way to tune the Energy Plan over the 10-year time span

Supporting tools

- The evaluation methodology and the monitoring process can be supported by a parametric software tool that can both help the Energy Manager monitor the progress of the plan and provide a high-level decision cockpit for political decision makers

THANK YOU

Any questions?