Ponte di Archimede (PdA) developed a tidal energy device, Kobold ®, already tested as full-scale prototype inside Strait of Messina (Italy).

Nowadays, PdA is interested in exporting knowledge of its device; thus Kobold® is going to be applied in Indonesian seawaters, Chinese and Philippine ones.

This is an additional sign as Europe is one of front-leaders in renewable energy technologies and it is working to assure its leader-position on competition market at worldwide level.

THE PROJECT FOR INDONESIAN COAST IS PARTIALLY SUPPORTED BY UNIDO FUNDS. THERE ARE SEVERAL AIMS LINKED WITH THIS PROJECT, SUCH AS:

- **helping developing countries – as Indonesia – to get electricity energy in a clear way, to improve its economy assuring more independence on energy market, to create new job-positions and with new skills;**
- **helping PdA to test device in new location and to learn more and consequently to get a faster learning rate to decrease future cost of technology;**
- **helping a sustainable world's growth;**
- **creating and stimulating interests for ocean energy sectors.**

A joint-venture company, Kobold Nusa PT, between PdA and the Indonesian company Walinusa Energy PT was created in May 2006 to build and implement this technology in Indonesia.

In the project there is a clear intent to help a developing country to "import" innovation and technology, and on the other side there is willing of PdA to obtain new knowledge of its device in a sea-environment different from its previous experience in Italy.

Figure below is showing the quota-weight relative to each step of project according with its costs. Then, from this we are going to consider the socio-economic impact inside Indonesian economy.

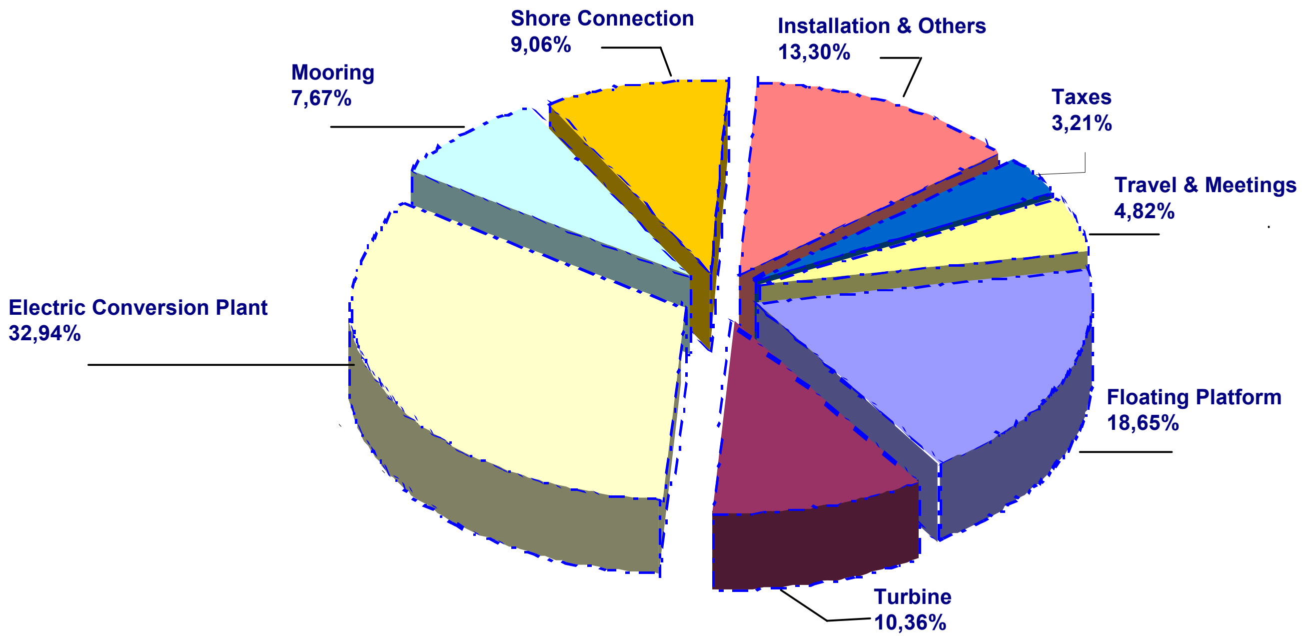


Fig. 1 Sectoral dimension of project

Learning Curve

The observation that costs decrease with adoption, or cumulative production, has been formalised in so called experience curves. They describe how the unit cost, c decrease with cumulative production, S.

$$c = c_0 \left(\frac{S}{S_0} \right)^{\beta}$$

where c_0 is the initial unit cost and S_0 the initial cumulative production at time t_0=0 and the experience index β:

where r_p is the so called progress ratio. A progress ratio of 0.80 means that costs decrease by 20% for each doubling of cumulative production

$$\beta = \frac{\ln(r_p)}{\ln(2)}$$

Anywhere along the line, an increase by a fixed percentage of the cumulative production gives a consistent percentage reduction in price. In the literature, comparisons between different experience curves are made by doubling the cumulative volume; the corresponding change in price is referred to as the progress ratio.

Forecast of tidal-energy power installed at world-wide level by EPRI (Electric Power Research Institute)

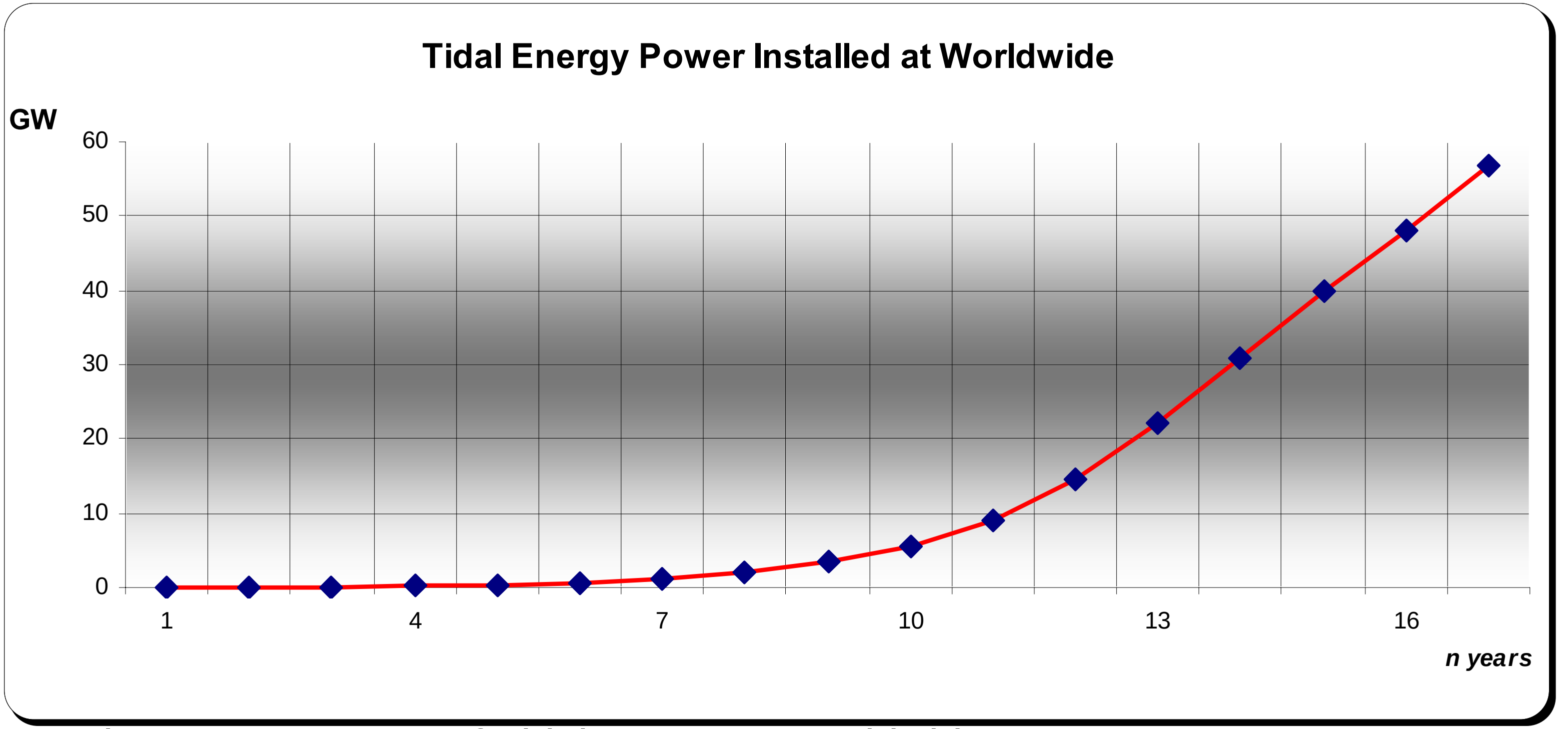


Figure. 2: Forecast of Tidal-Energy at worldwide, EPRI-2006

From this forecast, it is assumed a variable quota of participation of Kobold system that is able to assure following hypothetical scenario as shown in figure 3.

The scenario proposed is constructed according to actual status of development of technology, consideration of further in installations, testing and demonstration results and degree of understanding of its working.

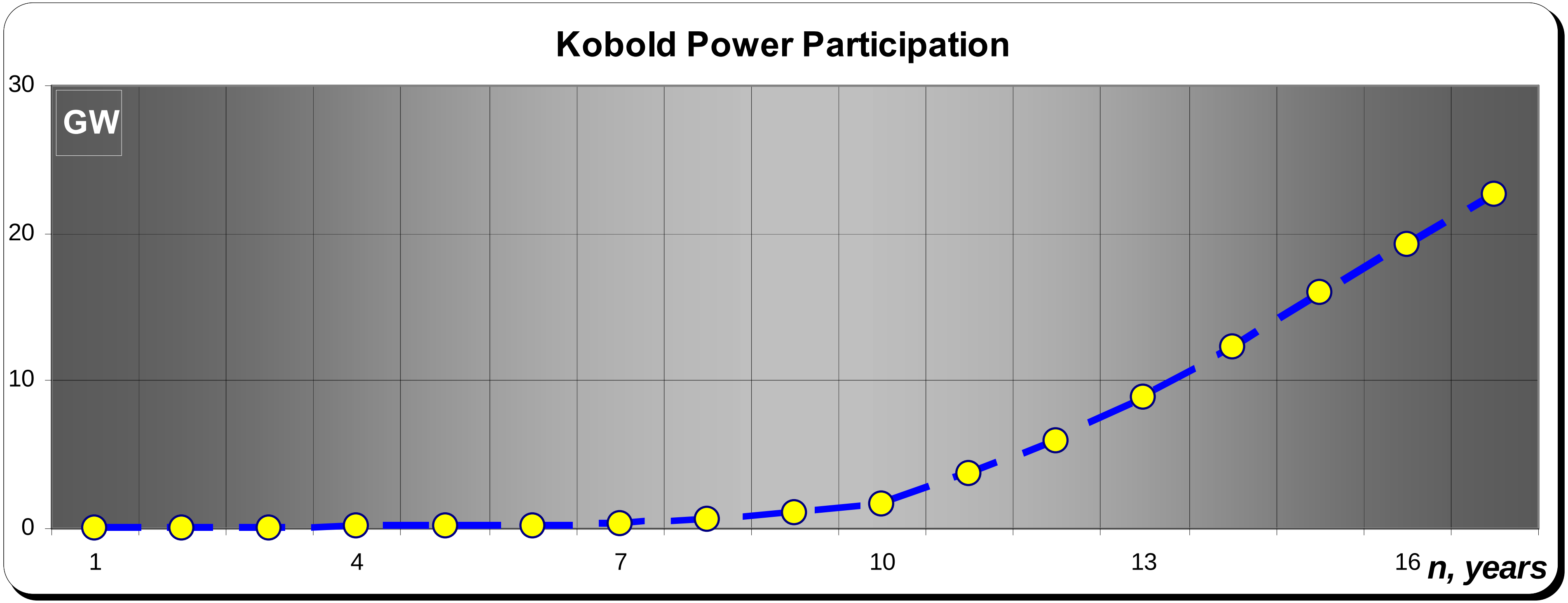
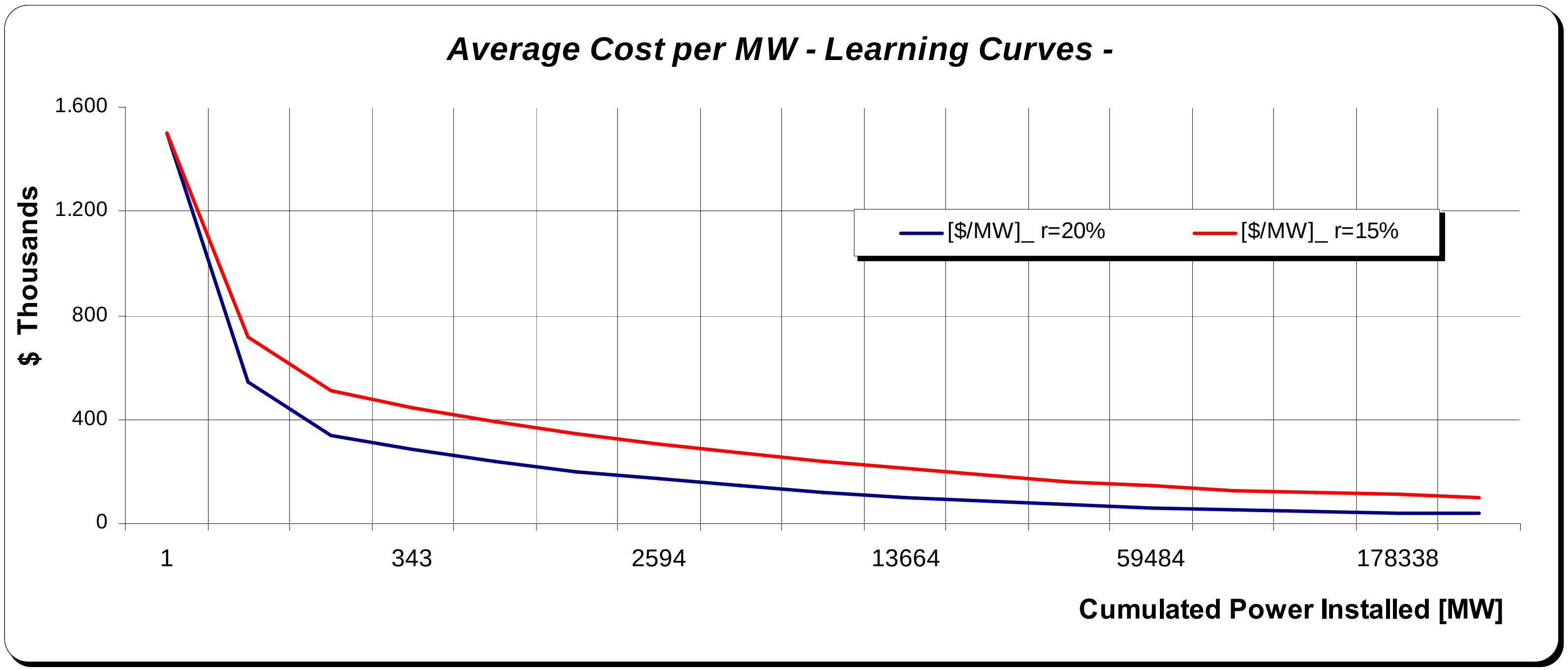


Figure. 3: Power Installed as Kobold system at worldwide

This scenario is able to get a decreasing cost per MW as provided in Figure 4, where the effect is shown of different learning rates (constant 20%, constant 15% and variable one from 20% to 13%). It is easy to understand that with only a cumulative power installed around of 24 MW the cost of an additional MW is already three times less expensive than the initial MW.



Cumulated Power Installed [MW]

Figure. 4: Learning Curves with different learning ratios

The cost of a MWh can been calculated considering an annual ratio of 1.600 MWh/MW. It starts from 938 US$/MWh (1.500.000/1600) and is decreasing to 69 US$/MWh at a cumulative power installed around of 14.000 MW.

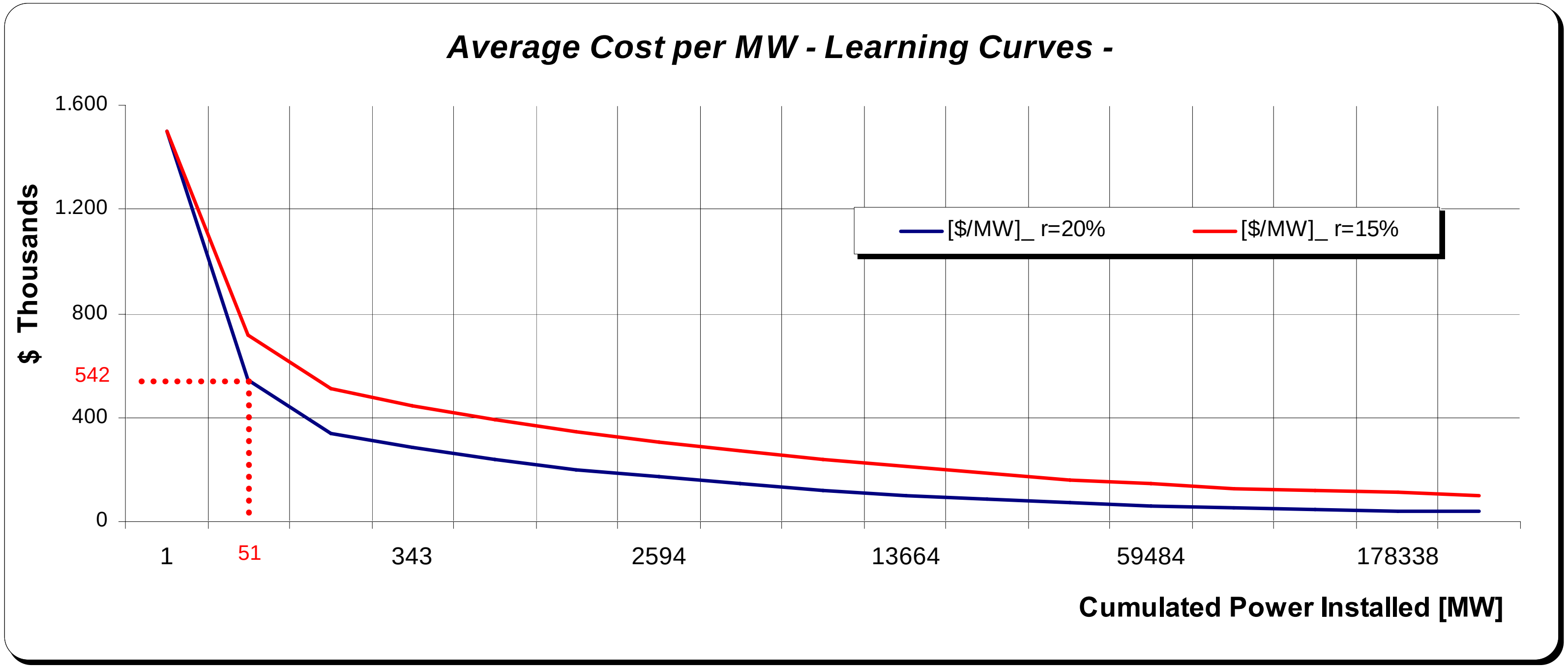


Figure. 4: Learning Curves with different learning ratios

Net Present Value -NPV-.

NPV indicates the difference between the present value of cash inflows and the present value of cash outflows.

$$NPV = -I_0 + \sum_{k=1}^{n} R_k \left(\frac{1+e}{1+d} \right)^k - \sum_{k=1}^{n} C_k \left(\frac{1+g}{1+d} \right)^k$$

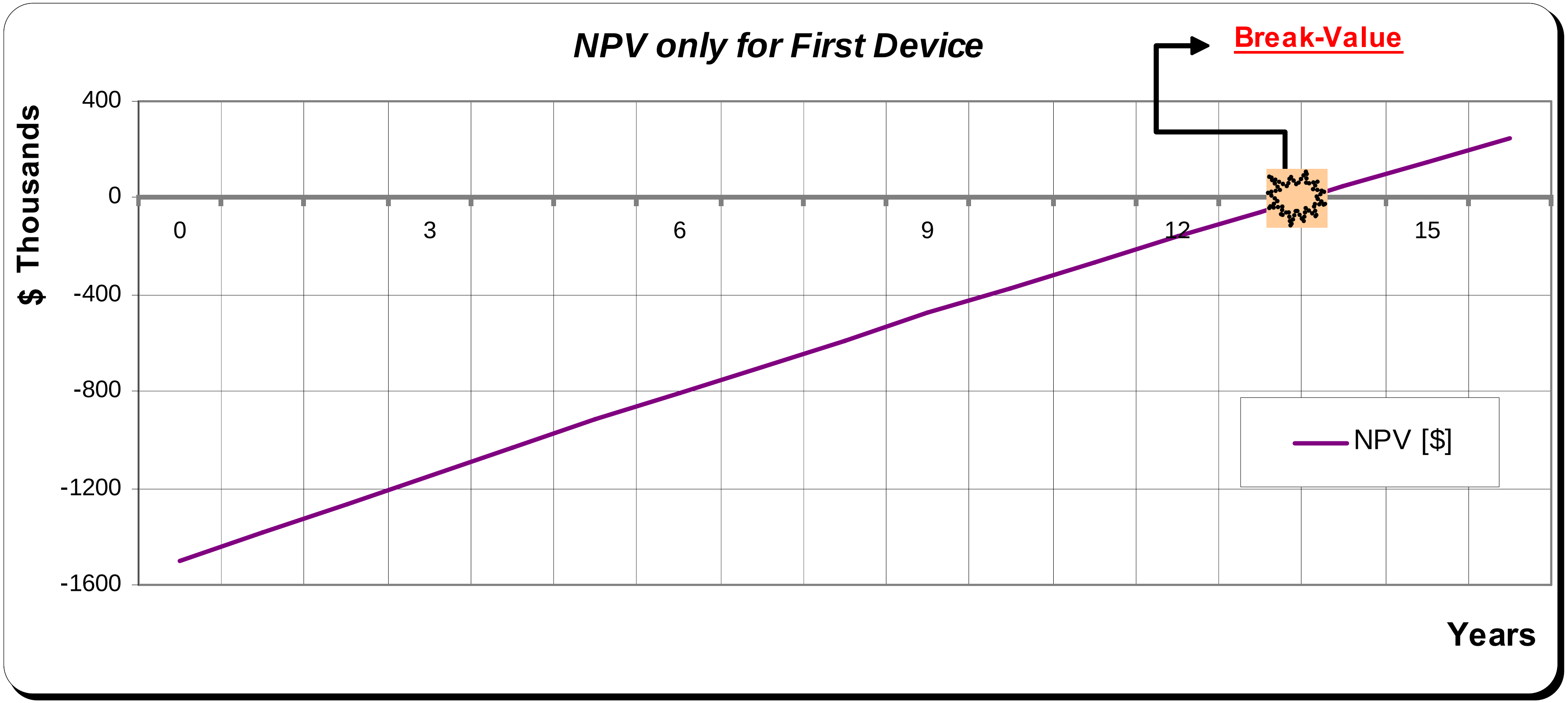
According with Indonesian economic settlement, data considered are:

- **I_0 (initial cost) = 1.500.000 US$/MW;**
- **e (energy inflation ratio) = 6,8%;**
- **g (general inflation ratio) = 6,6%;**
- **n (plant life time) = 25 years;**
- **d (discount ratio) = 8%.**

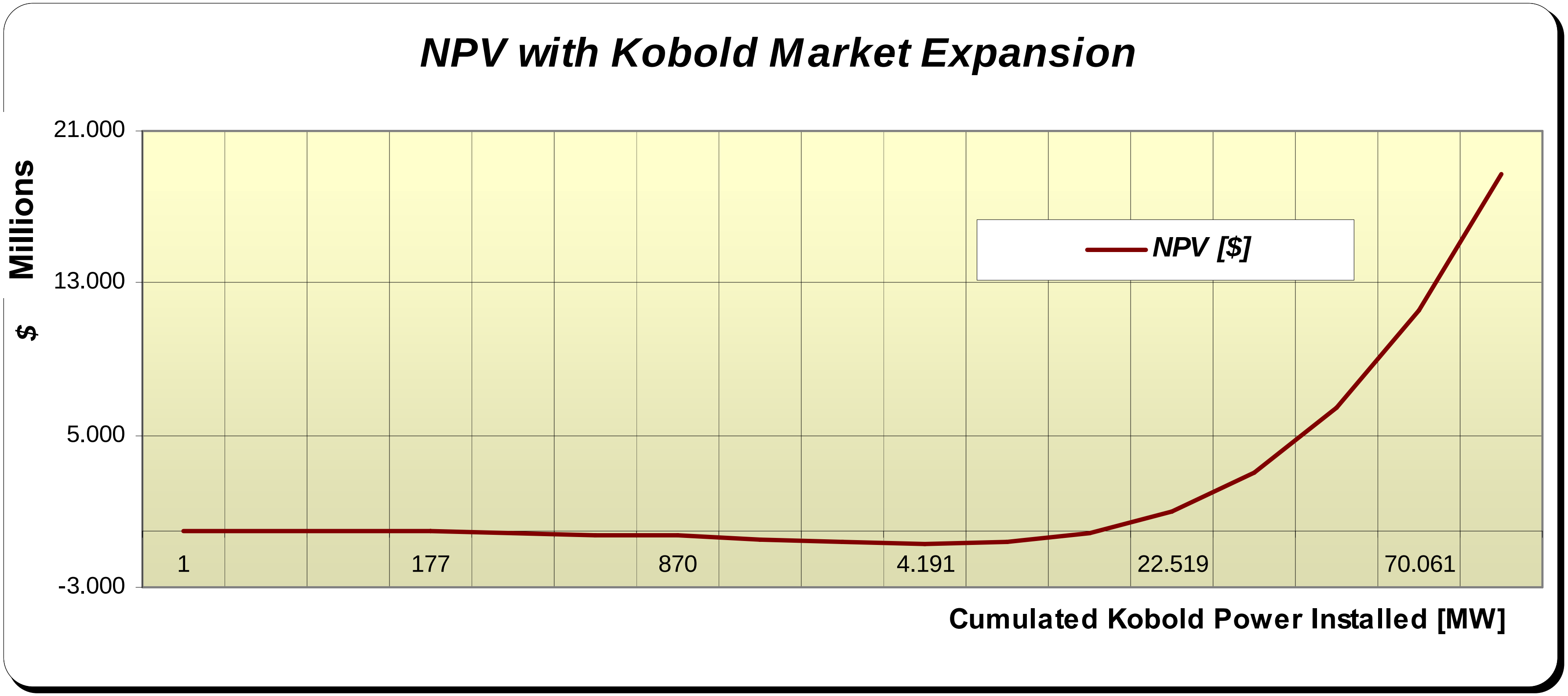
In addition, revenue is coming from electricity price of 42 US$/MWh, electricity production is coming from an annual ratio of 1.600 MWh/MW.

Initial Costs C_1 are assumed to be 3,4% of I_0

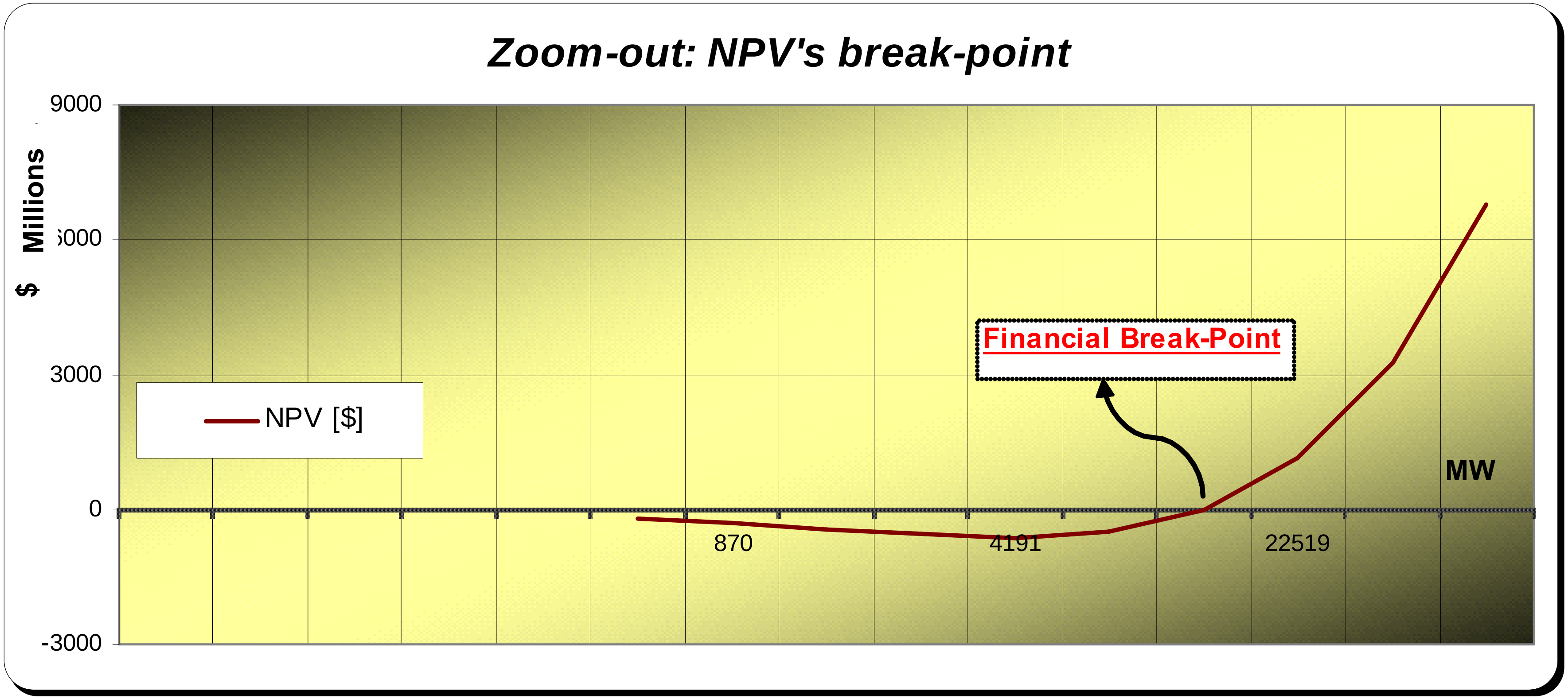
NPV of single project of a Kobold system in Indonesia



NPV with a growing expansion of Kobold system as described in previous section.



Zoom-out of zone with NPV positive



Previous experience in Indonesia from the biomass energy industry has shown promising potential for such systems in providing job opportunity and income for unemployed.

In order to accelerate economic recovery, Indonesia has given high priority in making use of its marine resources by effectively applying renewable energy technology.

Renewable energy can be utilized to improve quality of life of rural household. Tidal energy is an environmentally friendly technology.

The directorate general of electricity and energy development has estimated that the total energy consumption will increase with an increasing ratio of 26%. The highest energy demand is expected to come from the transportation sector while the household sector will remain at the third place.

In line with the above government policy, renewable energy projects are with aim to help the rural people with facility to increase value added of their products, provide job opportunity and source of income.

An important issue, usually discussed in association with the introduction of new technologies and innovation, is the relation of job losses and job creation.

Additional jobs will arise in two categories, indirect and induced. Indirect jobs are those required to support the main workers, induced ones are those caused by the increased economic prosperity when the new employees increase their consumption in other areas such as entertainment.

Most of the studies showing relation between MW power installed and number of jobs, consider only the absolute potentiality of the type of technology for job creation. Here, a different approach is followed; the interesting issue is to know how many jobs a country's economy can make when additional MW power are installed.

A MW power installed is a “special good” like money, because a MW does not have the same potentialities and values in each country-economy and in addition it does not have a level of pleasure saturation. We never find a country refusing additional MW even if it is rich!

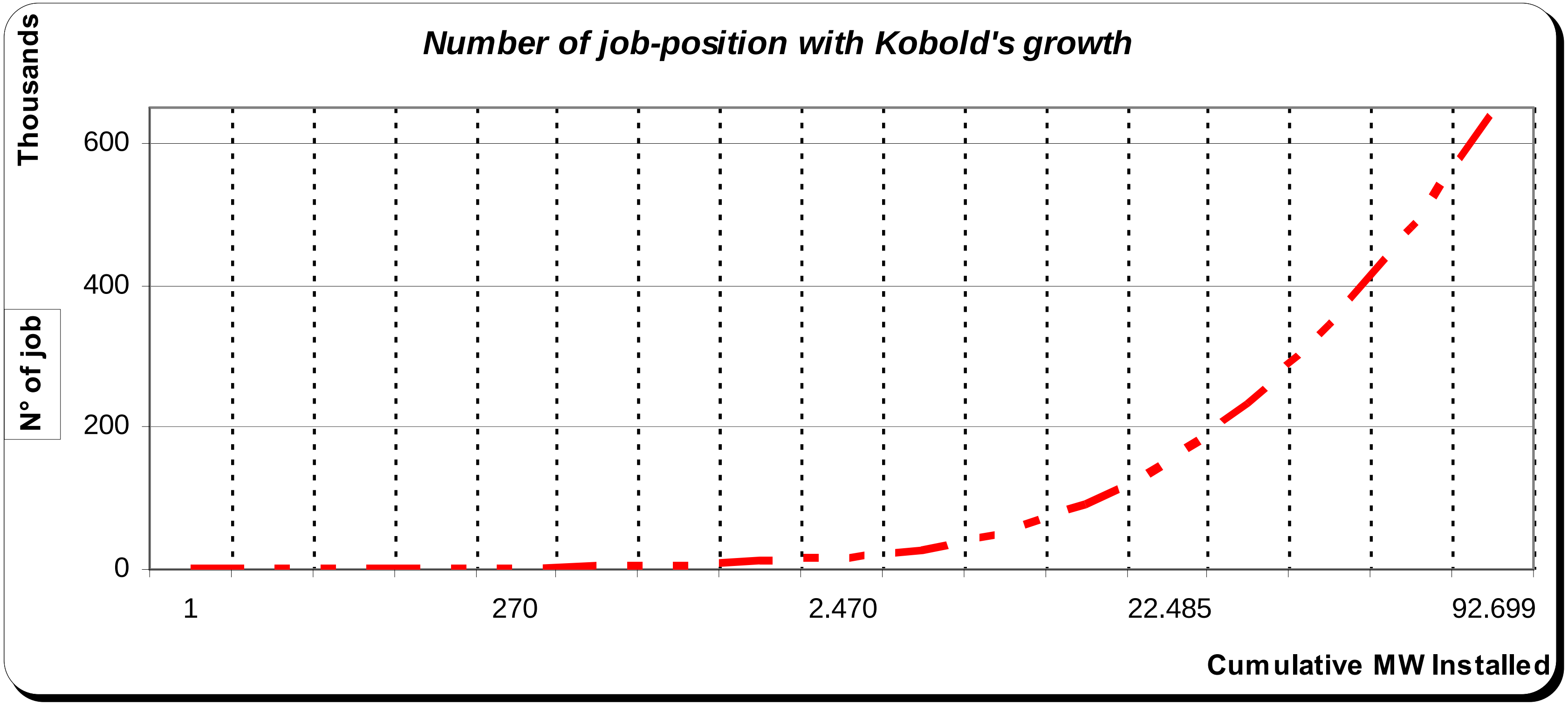
GDP - Gross Domestic Product - in MW units (GDP_{MW}) is considered as distributed over production sectors (Industry and Services); then we consider GDP per sector over the number of employees for each sector:

$$GDP \quad \frac{E}{MW}$$

Then, it is considered the resulting relation of value per employee with its forecasting according Indonesian time series. From these results, numbers of jobs, linked with further MW power installations in the country, are estimated. Indonesia’s economy is able to get a coefficient of employee per MW around of 0,17 to 0,14.

Situation, according with the hypothetical scenario presented beforehand, is shown in Figure below:

Coefficient Employee/MW from 0,17 to 0,14



THANK YOU FOR THE ATTENTION