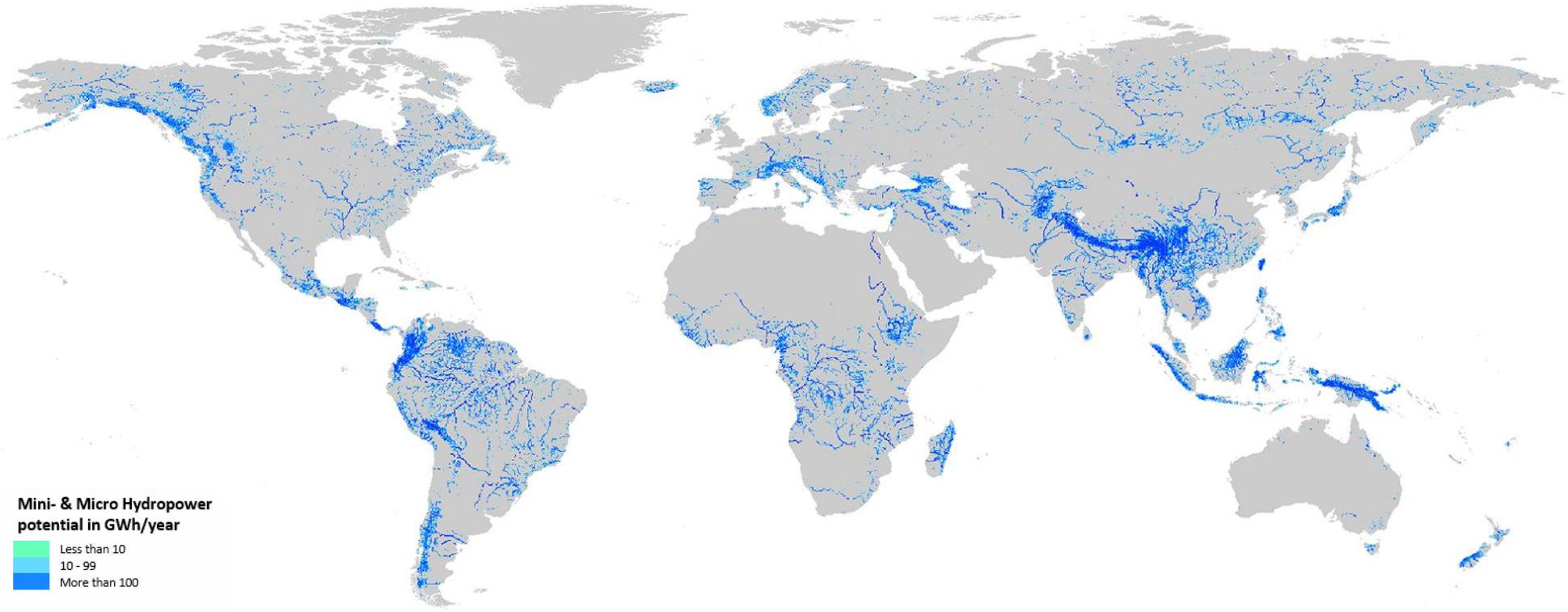

the plug & play hydropower
to electrify millions of
off-grid homes and businesses

2.4 billion people do not have a reliable electricity supply. This limits their ability for economical and societal development. These people are unable to increase agricultural and commercial productivity or to improve health care. They are unable to improve their quality of life.

Affordable, reliable and sustainable energy is therefore one of the United Nations' Sustainable Development Goals. Network expansion is extremely expensive and will not be the solution. It is known that distributed energy sources will play a major role in reaching the goal of global electrification.

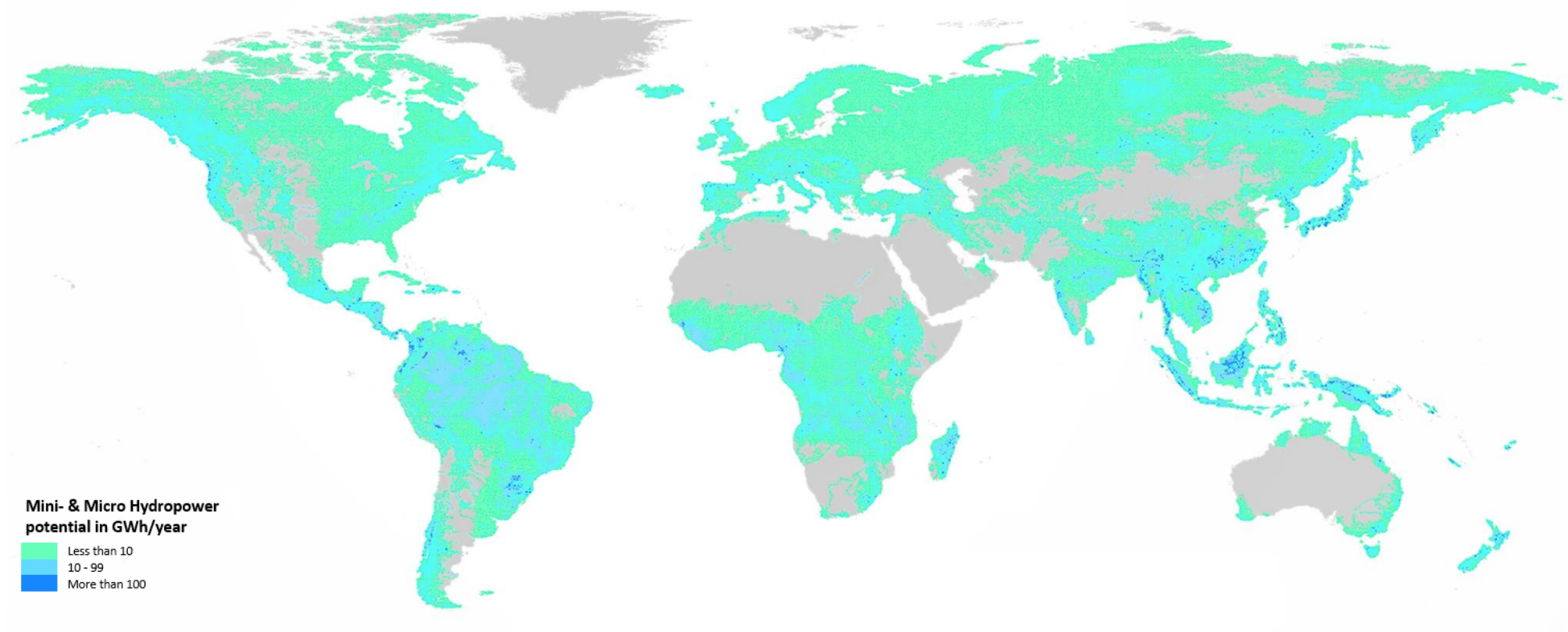
Highly centralised large hydropower



Source: Hoes OAC, 2017

Hydropower is a reliable and cheap source of electricity but conventional hydropower is mostly utilized in large scale projects. However, large scale hydropower is seen as problematic from an environmental perspective and is only available in certain and very limited areas on the globe. Once implemented an extensive infrastructure for electricity distribution is needed which does not reach remote and rural areas.

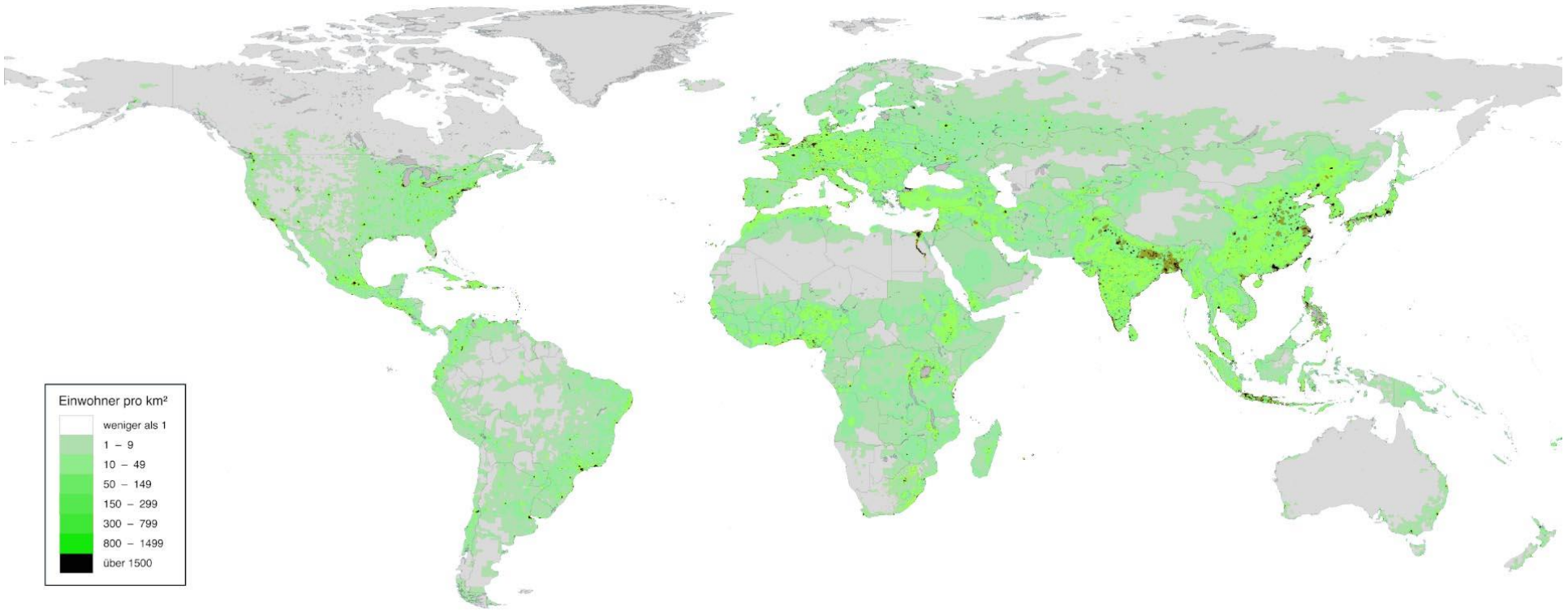
Evenly distributed mini hydropower



Source: Hoes OAC, 2017

Mini- and micro hydropower, however, is evenly distributed over the globe. Especially very-low-head hydropower is not even limited to mountainous areas but can be utilized also in flat areas. According to recent studies of hydropower potential, mini- and micro hydropower is sufficient for 1/3 of the global electricity demand and is therefore a very relevant source of renewable electricity for upcoming years.

Population density



Source: Kummu M., 2012

This slide shows the population density distribution on a global perspective. Compared to the slides before, showing the hydropower potential, it can be clearly seen that there is a large overlap with the smaller potentials. Mini- and micro hydropower is available where people had settled down as 50% of the population lives closer than 3 kilometres to surface waters.

doro-C: World‘s first plug & play hydropower plant

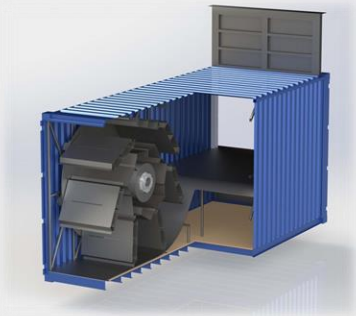
35 kW

350

3,500 tons

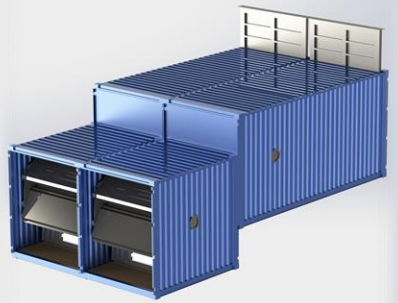
doro-Compact is the world’s first plug & play hydropower plant and gives access to cheap and reliable hydro electricity for non-experts. It delivers 35 kW with one single turbine set. As the production is constant during day and night it is a very reliable source of electricity even without extensive storage systems. The output is sufficient for the average consumption of 350 households in emerging countries. This is how doro-C avoids 3,500 tons of CO2 emissions over its lifetime.

doro-C: PCT patent-pending



Patent-pending

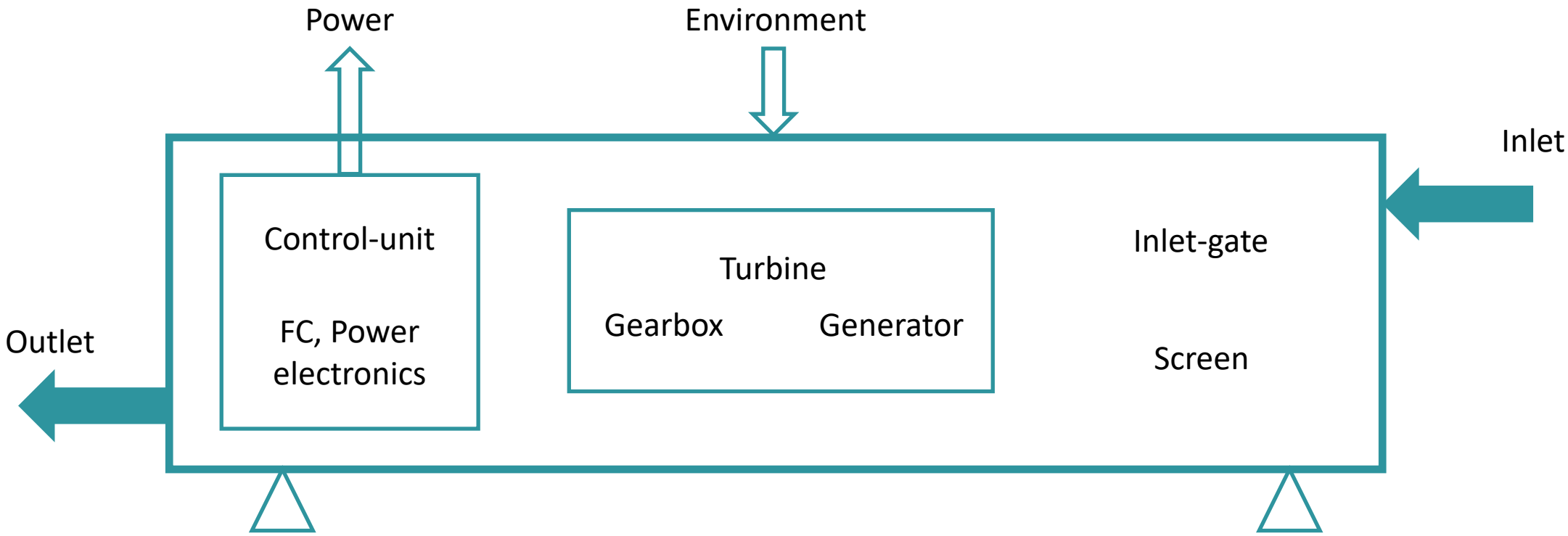
Modular & standardised



Compact & mobile

The doro (double rotation) turbine is globally patent-pending and was developed over three years of basic research. The doro-C system is modular and standardised and can be put together for serial as well as parallel installation, depending on the water source. As the shell of doro-C is a standard 20ft HQ container it is mobile and can easily be transported. Moreover the shell protects the components in events of flooding.

Solution: Interface reduction & simplification



Utilizing smaller hydropower potentials in an efficient and economic manner is a big challenge. doro-C is tackling this problem by broad simplification measures and interface reduction. Compiling every component of a hydropower plant into a (black-)box gives the opportunity to standardise and to completely prefabricate the whole powerplant. This is how project development risks and cost as well as CAPEX is going down tremendously. Moreover, as the major cost block of the whole powerplant are moveable assets, attractive financing models are applicable which have not been applicable for hydropower yet.

doro-C: Plug & play without expertise

1

Initial situation: Head 0,7 to 1,5 meters (sudden drop or sloping riverbed)

2

Excavation works besides the river bed

3

Foundation, securing the walls

4

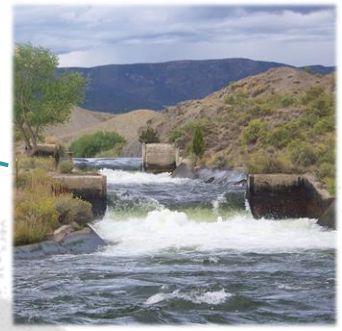
Installing the doro-C onto the foundation without blocking the actual river

doro-C utilizes the energy of drop heights of only 0.7 to 1.5 metres. It can be installed in the area of river banks without blocking the actual river. This is why moveable weirs are not necessary in order to enable flood discharge. For the installation process itself only simple excavation and foundation works have to be undertaken. We aim to enable people who have experience in the planning and construction of photovoltaic to utilize hydropower without expert knowledge.

Typical sites



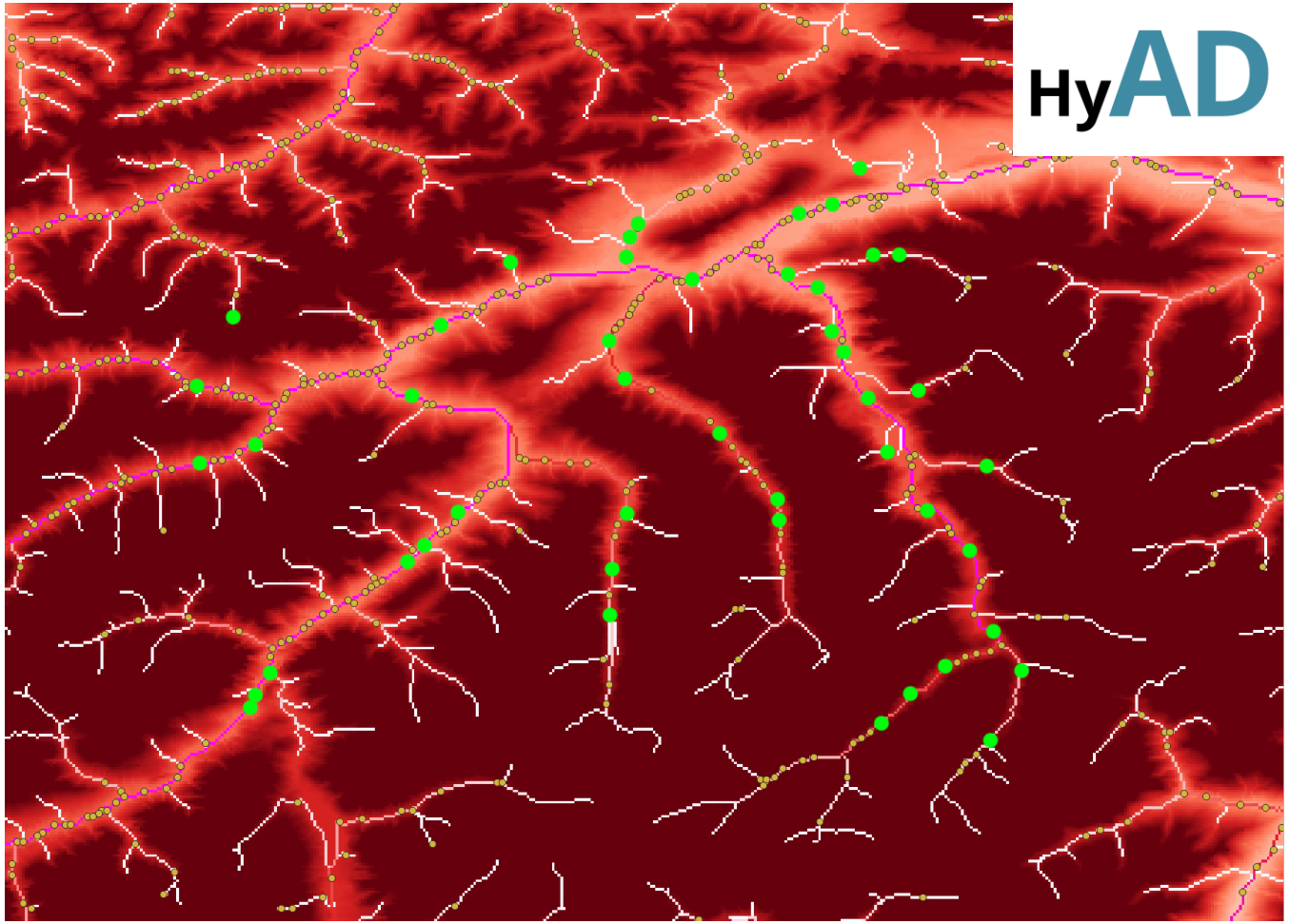






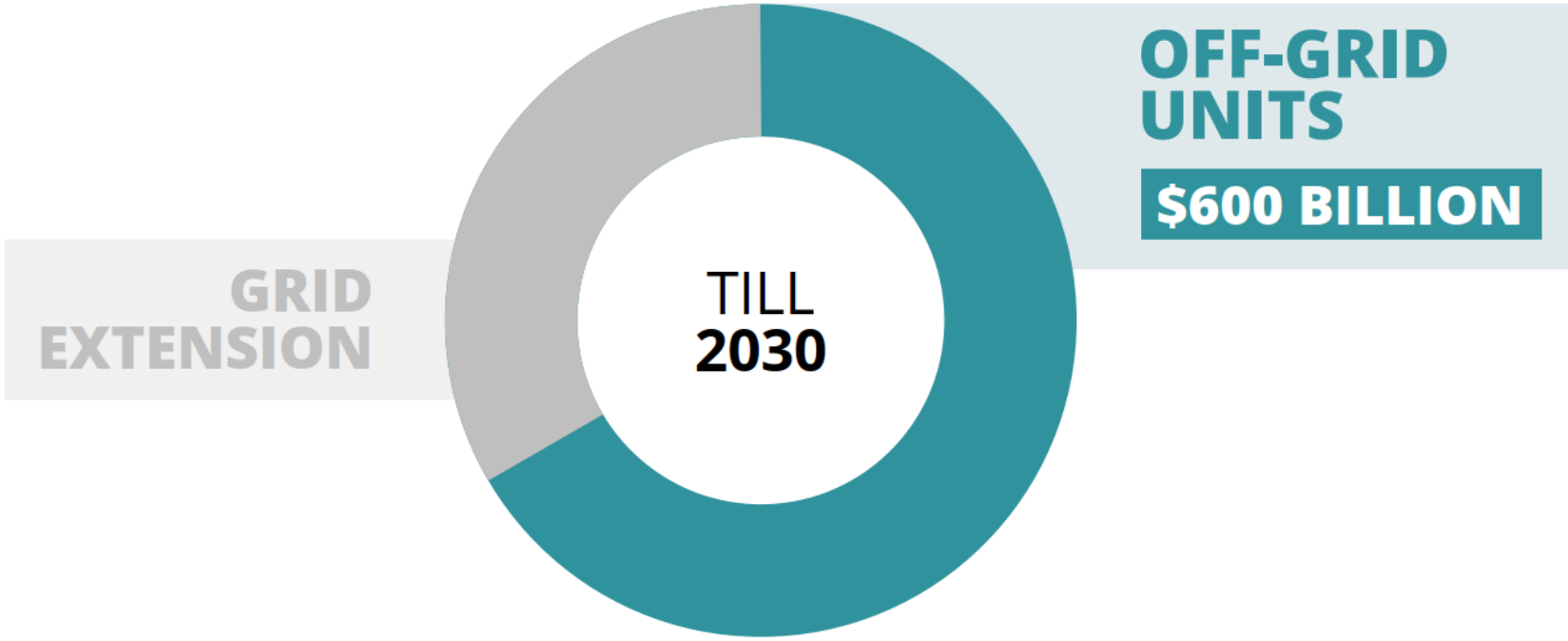


GIS-based assessment



As mini- and micro hydropower is not limited to mountainous areas they can be found theoretically everywhere. Nevertheless, some locations are more suitable than others, of course, but they have to be evaluated in an efficient manner. Due to our close cooperation with HyAD GmbH we can offer a GIS-based assessment toolbox which identifies and evaluates hydropower sites and calculates various KPIs supporting decision-making. Of particular interest for developers is the possibility to identify populated areas with a relevant hydropower potential.

Market: Rural electrification



Sources: IEA, 2010; UN, 2010

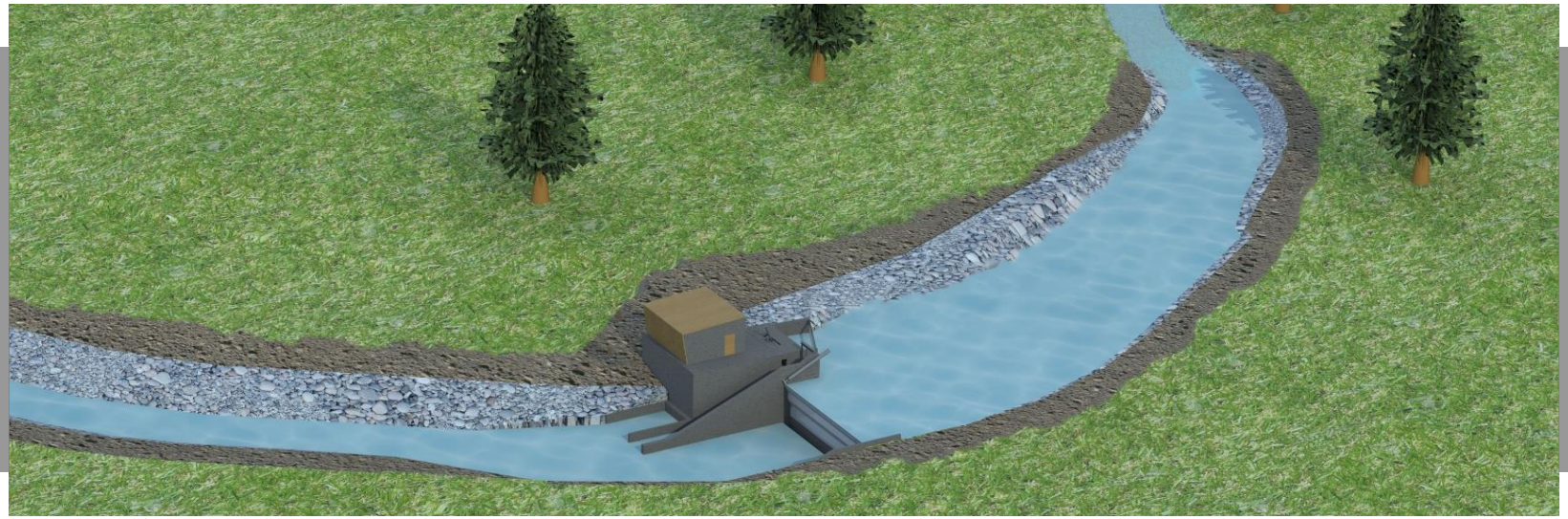
Till 2030 the rural electrification will be dominated by decentralized off-grid electricity producers. Especially microgrids will play a significant role as investments in this sector will grow from 2.4 BUSD today to 21.5 BUSD annually in 2026. So far, authorities and government institutions, NGOs and, in some cases, small, local companies have been the driving forces behind the growth of microgrids. Over the past 3 to 4 years, there has been a shift towards greater private sector for financing, development, operation and management of mini grids. Actors range from local entrepreneurs to large, international utilities and especially impact investors.

doro-C vs conventional hydropower

3x doro-C in a row: 105 kW

(EUR 120,000 to 145,000 per container depending on quantity, product version)

Hydraulic steelwork:	€	----------
Construction work	€	92,409
Machinery (3 x doro-C):	€	360,000
Overall costs:	**€**	**452,409**
Annual return (0.11/kWh)	**€**	**~62,000**



Conventional hydro power plant 115 kW

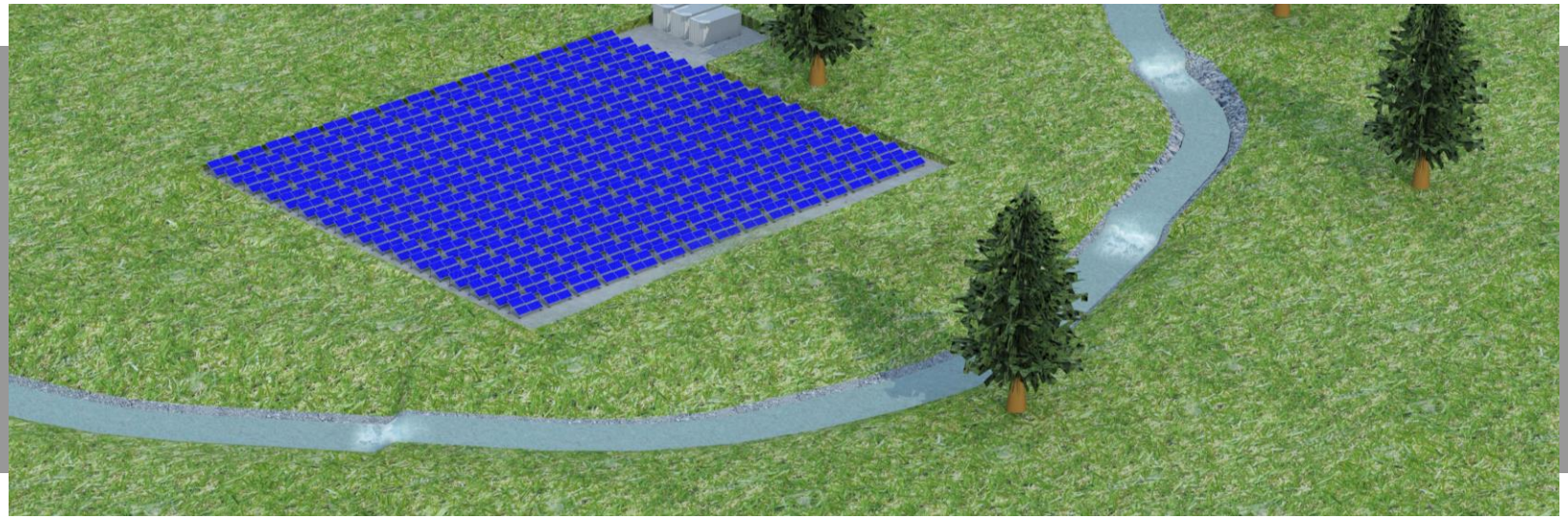
Hydraulic steelwork:	€	166,240
Construction work	€	464,150
Machinery (Kaplan):	€	385,000
Overall costs:	**€**	**1,015,390**
Annual return (0,11/kWh)	**€**	**~67,500**

doro-C vs PV

3x doro-C: 105 kW

(EUR 120,000 to 145,000 per container depending on quantity, product version)

Hydraulic steelwork:	€	----------
Construction work	€	92,409
Machinery (3 x doro-C):	€	360,000
Overall costs:	**€**	**452,409**
Annual return	**€**	**~62,000**
(0.11/kWh)		

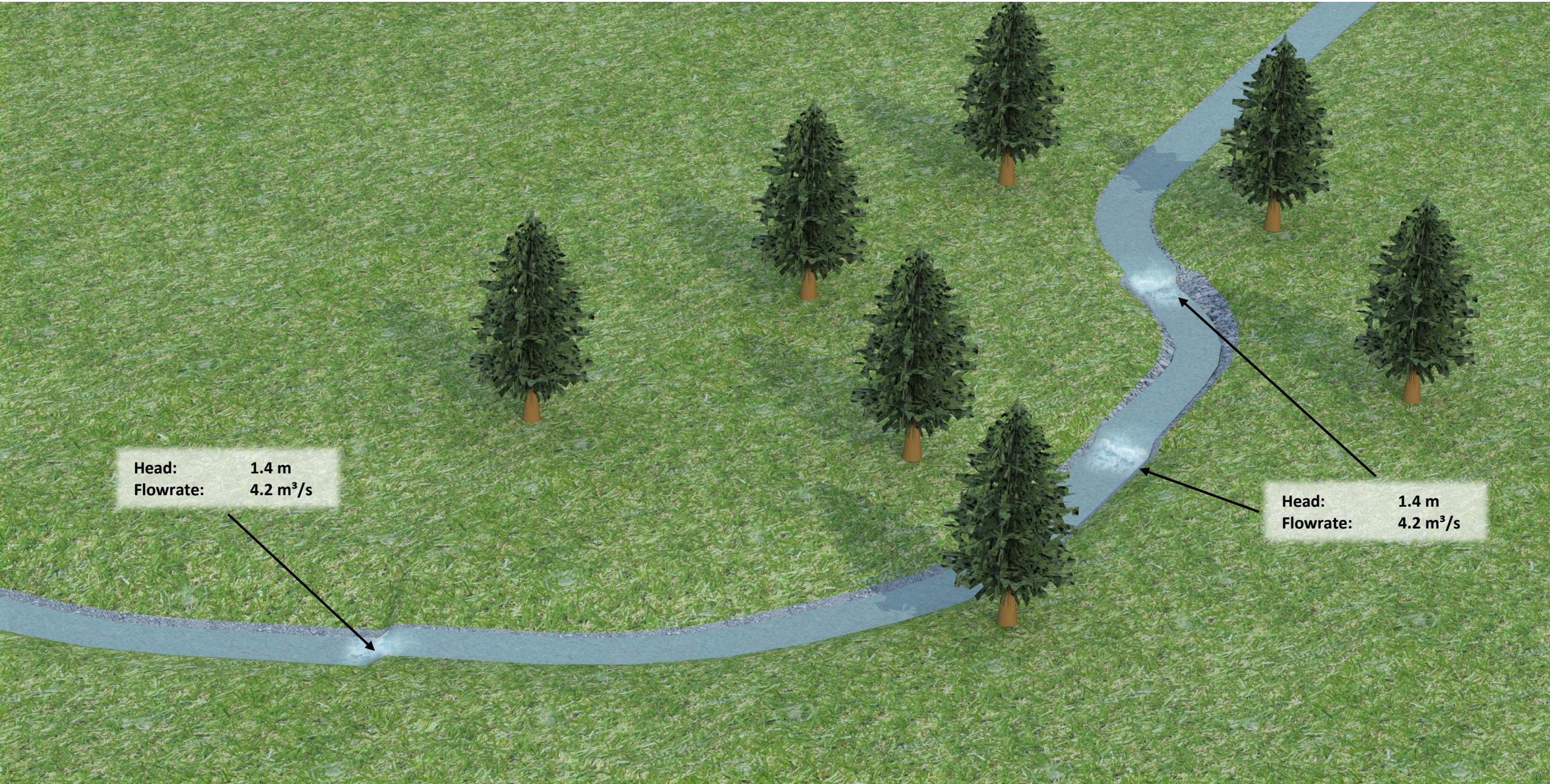


PV 400 kWp + battery 1700 kWh

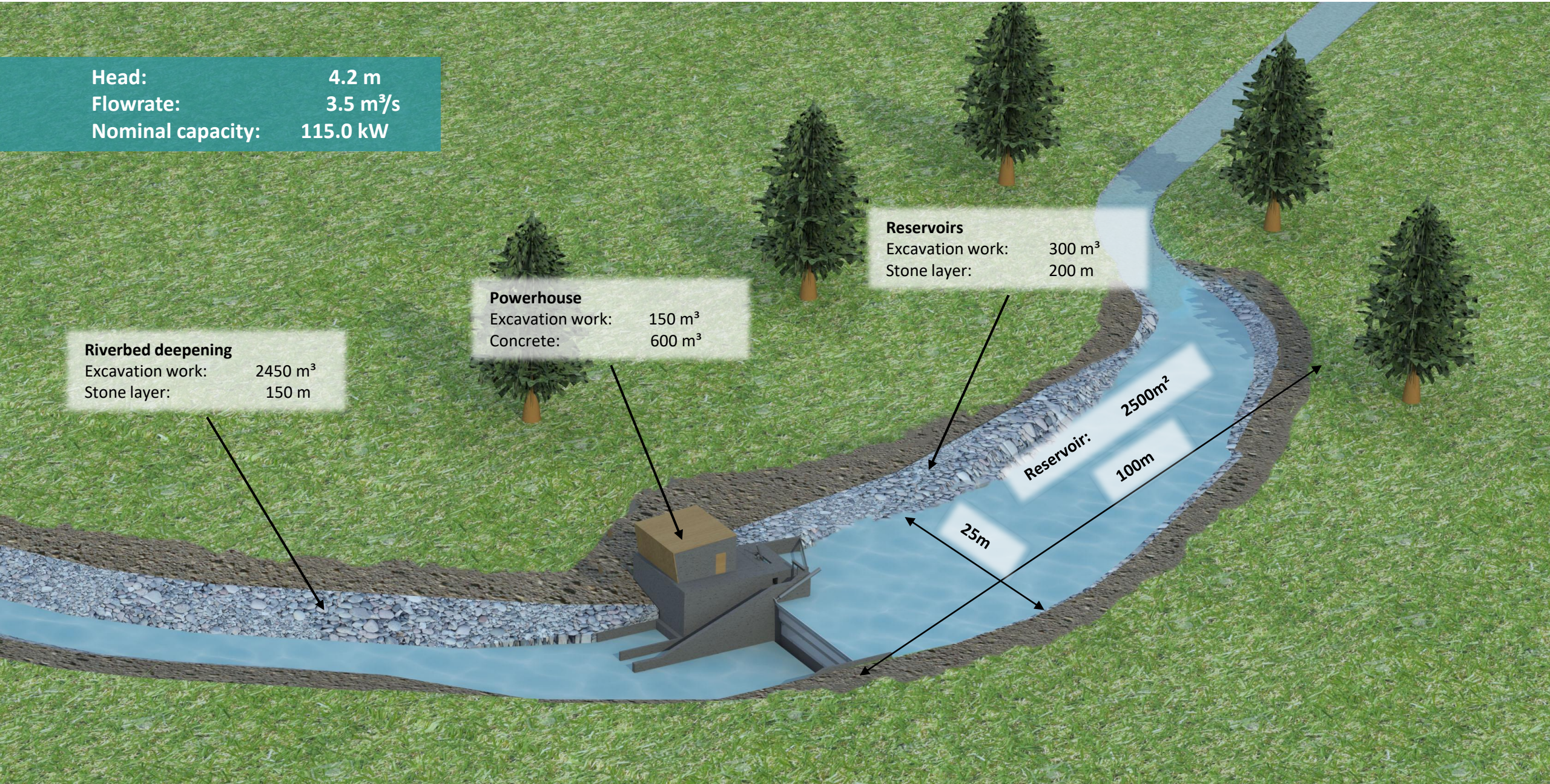
(for similar degree of self-sufficiency)

Battery (260/kWh):	€	450,000
PV 400kWp (800/kWp):	€	380,000
Overall costs:	**€**	**830,000**
Annual return	**€**	**~62,000**
(0.11/kWh)		

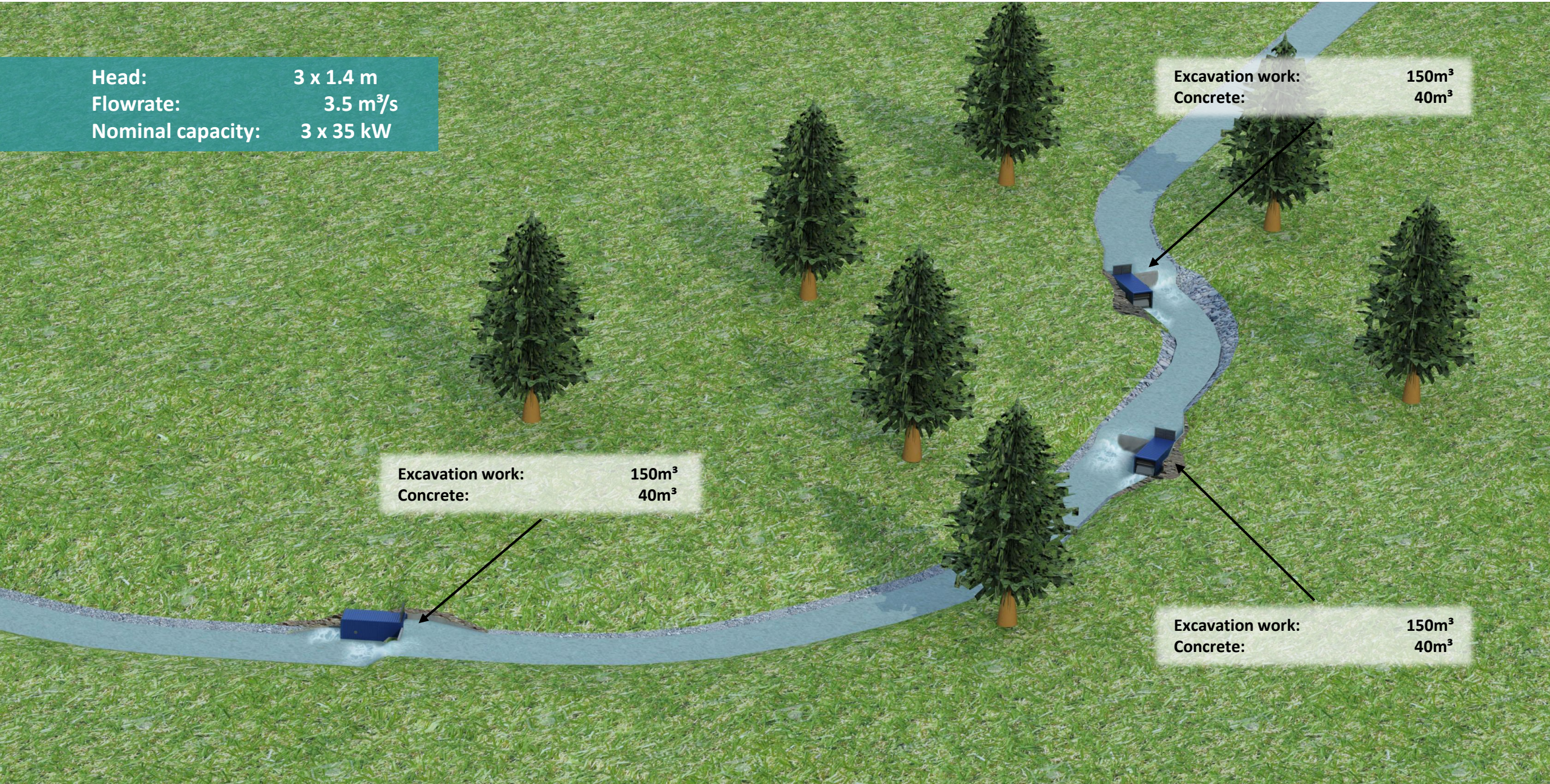
River situation



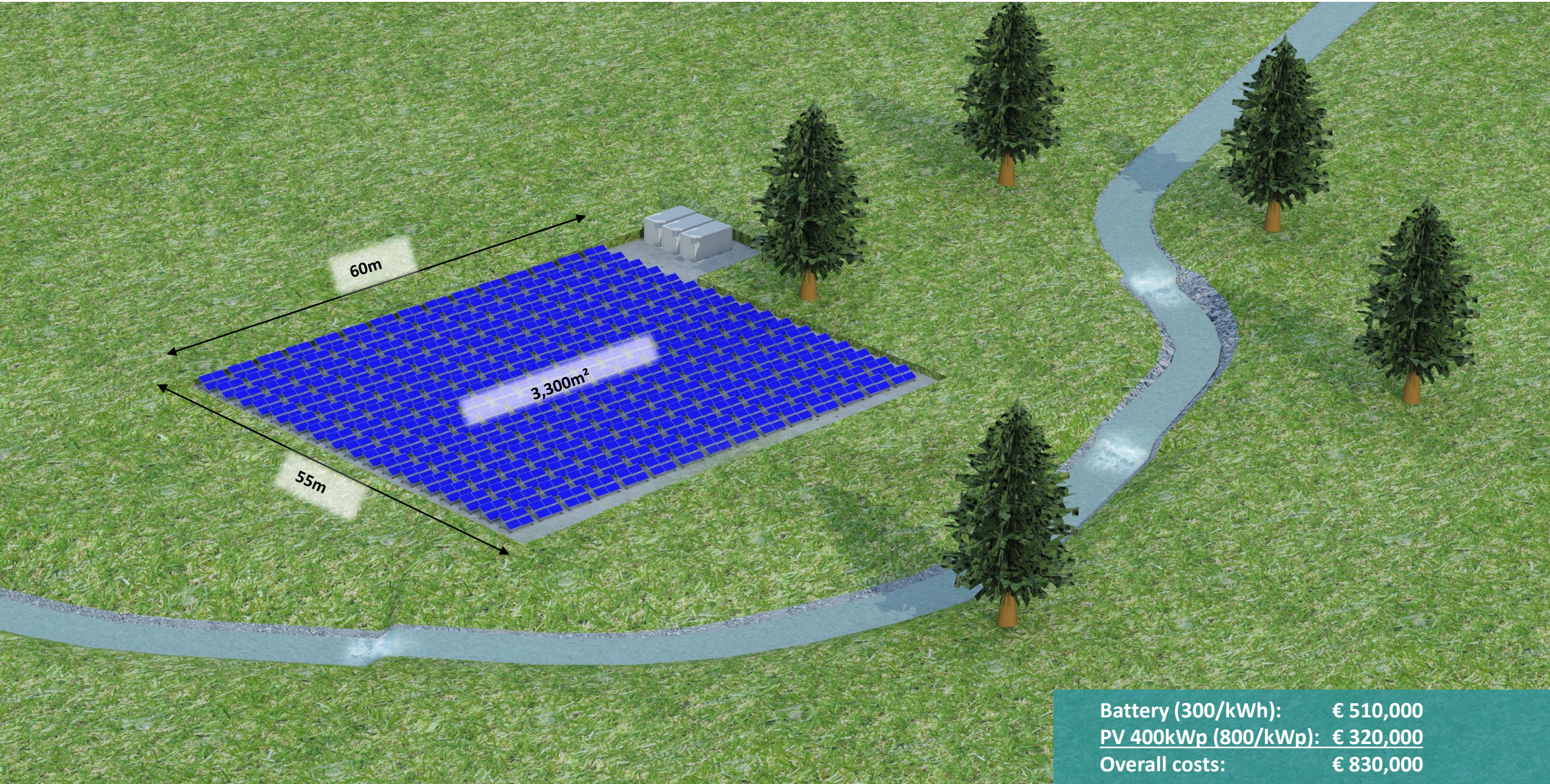
Conventional hydro power plant



doro-C

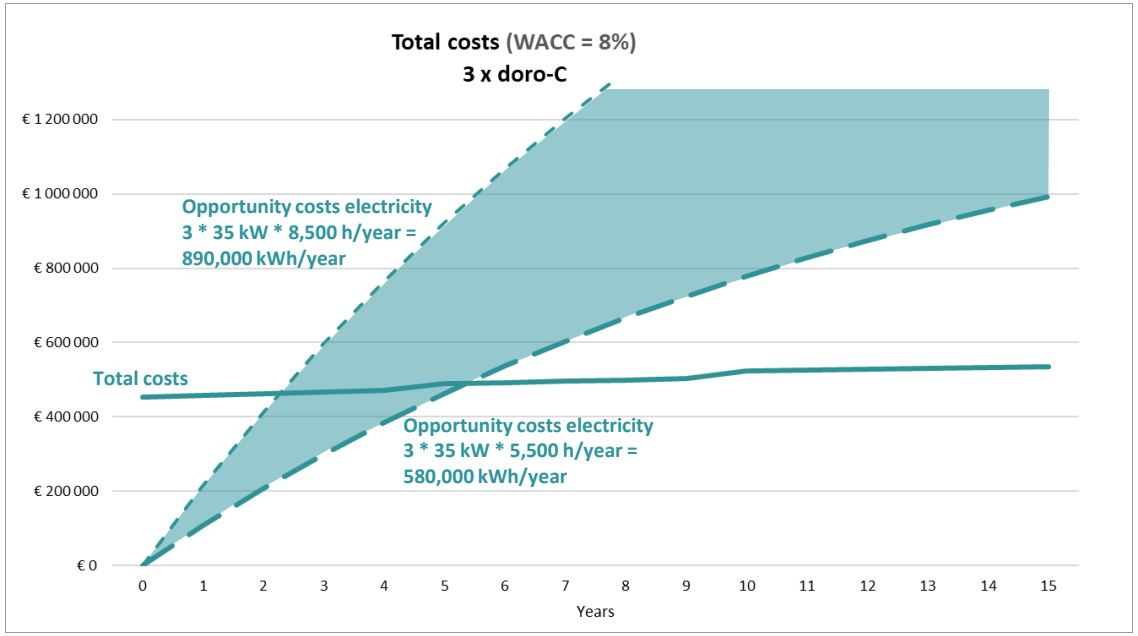

Head: 3 x 1.4 m
Flowrate: 3.5 m³/s
Nominal capacity: 3 x 35 kW
Excavation work: 150m³
Concrete: 40m³
Excavation work: 150m³
Concrete: 40m³
Excavation work: 150m³
Concrete: 40m³

PV with storage



Battery (300/kWh):	€ 510,000
PV 400kWp (800/kWp):	€ 320,000
Overall costs:	€ 830,000

Cost comparison – Base load supply

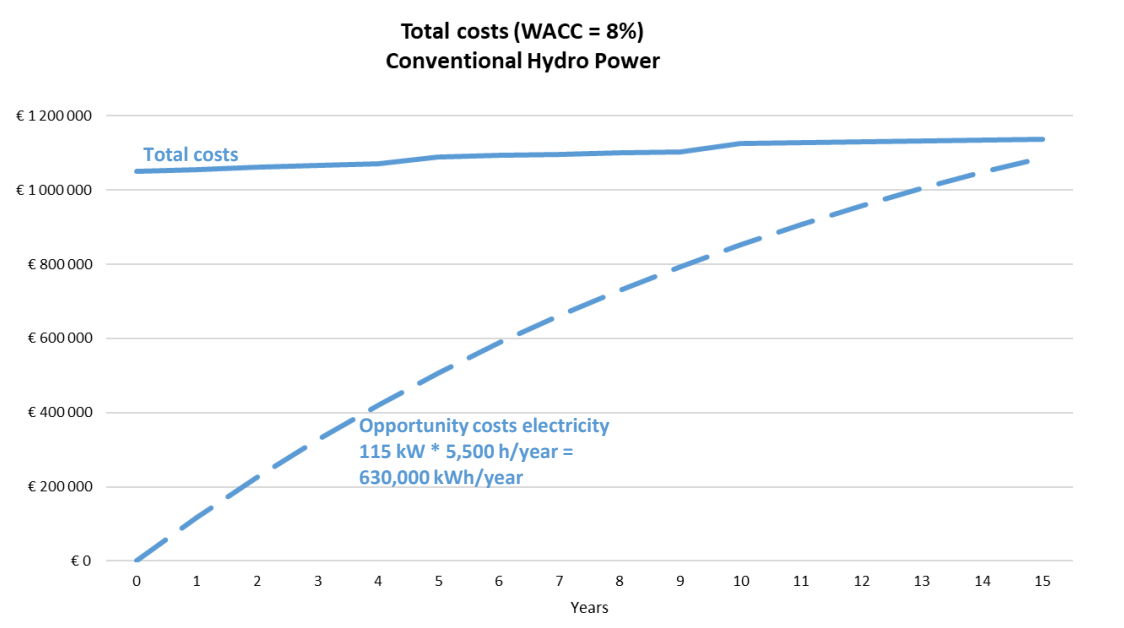


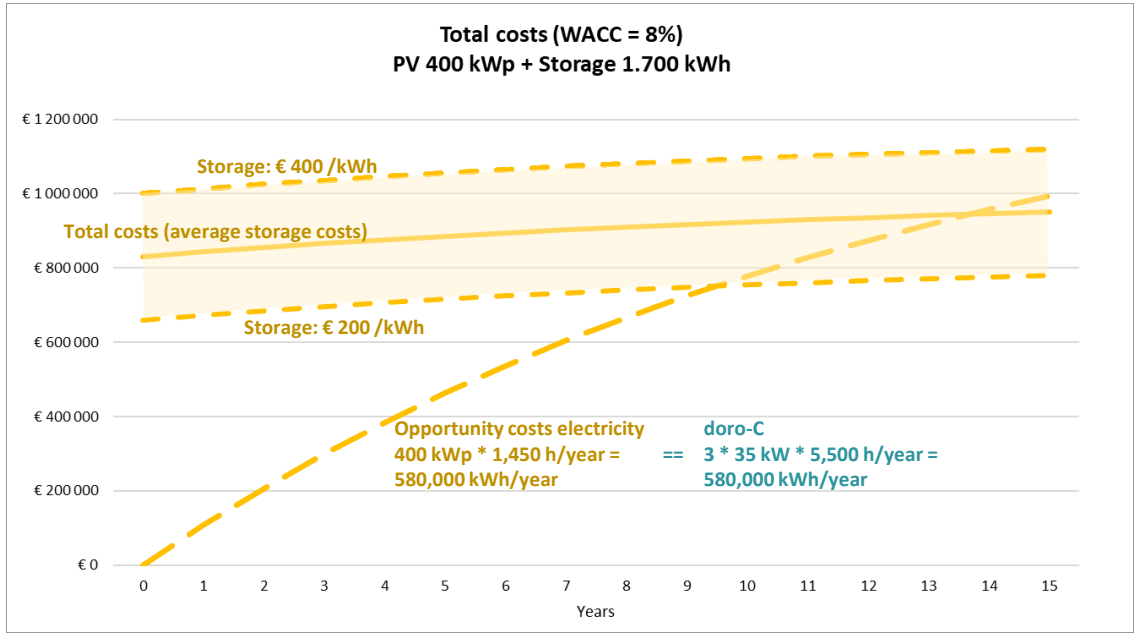
General
- Flat lines: CAPEX plus OPEX
- Rising lines: Opportunity costs of electricity (€ 0.2 /kWh)
- WACC: 8% (e.g. if equity ratio 30:70 and interest rate 6%
  -> anticipated return on equity 14%)

doro-C
- Depending on water flow: 5,500 h/year to 8,500 h/year
- Amortisation period 2 to 5 years

Conventional hydro power
- Amortisation period ~16 years

PV + storage
- Cost of PV-system very much depends on cost of storage (€ 200 to € 400 /kWh)
- Amortisation 9.5 to ~19 years





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