

Can the legal requirements be met by hydro power plants?

Rita Keuneke



FISH MARKET, Roermond

6-7 October 2016

Ingenieurbüro Floecksmühle
wasser umwelt energie

Ein Unternehmen der **FICHTNER** Water & Transportation GmbH

Legal requirements for surface waters

- ▶ EU Water Framework Directive (EU-WFD)
 - ▶ Good ecological status
 - ▶ Good ecological potential

Biological quality elements			
Phytoplankton	Macrophytes and phytobenthos	Benthic invertebrate fauna	Fish fauna
Hydromorphological quality elements			
Hydrological regime	River continuity		Morphology
Physico-chemical quality elements			
General conditions	Specific synthetic pollutants		Specific non-synthetic pollutants

- ▶ German Federal Water Act – Wasserhaushaltsgesetz (WHG 2009)
 - ▶ § 33 Minimum flow conditions
Sufficient flow according to the aims of the management plans
 - ▶ § 34 River continuity
Sustaining or reinplementation of river continuity by appropriate facilities and operating methods
 - ▶ § 35 Use of hydro power
Appropriate measures to protect fish population

Minimum flow conditions at diversion hydro power plants (HPP)

- ▶ Example plant
 - ▶ Design flow: 12 m³/s
 - ▶ Power output: 130 kW
 - ▶ Annual generation: 754.000 kWh/a



- ▶ $Q_{\min} = 0,3 - 0,5$ of average minimum flow
 - ▶ Minimum flow : 2 m³/s
 - ▶ Annual generation : 646.000 kWh/a
 - ▶ approx. 14 % less



► Construction of upstream migration facilities



Protection of fish population

- ▶ Fish protection and downstream migration facilities
 - ▶ Horizontal protection screens (10 to 15 mm clear width of bars)
 $Q_a \leq 50 \text{ m}^3/\text{s}$ per screenelement
 - ▶ Vertical protection screen (10 to 15 mm clear width of bars)
 $Q_a \leq 30 \text{ m}^3/\text{s}$ per screenelement
 - ▶ Appropriate bypasses



▶ Example HPP

- ▶ Annual gains: approx. 50.000 €/a
- ▶ Min. flow conditions: 10 to 15 % of annual gains
- ▶ Value of plant at 4 % interest rate and a remaining term of 20 years:
 $0,9 * 50.000 \text{ €/a} * 13,6 = 680.000 \text{ €}$
- ▶ Construction costs of upstream migration facilities
- ▶ Construction costs of fish protection und downstream migration facilities
- ▶ Total costs of measures: 830.000 €

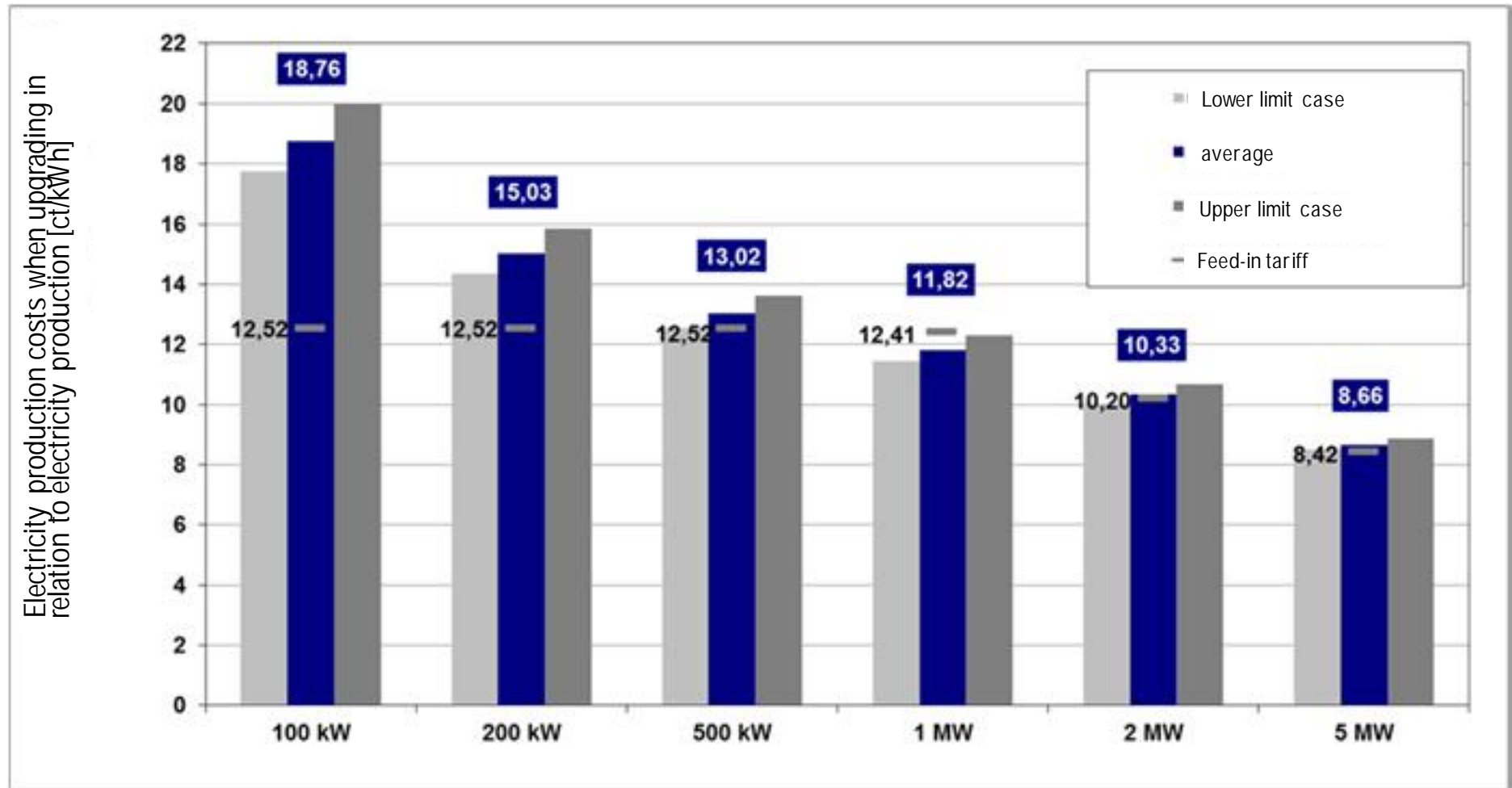
➔ Funding necessary

- ▶ Renewable Energy Sources Act - Erneuerbare-Energien-Gesetz (EEG 2017)

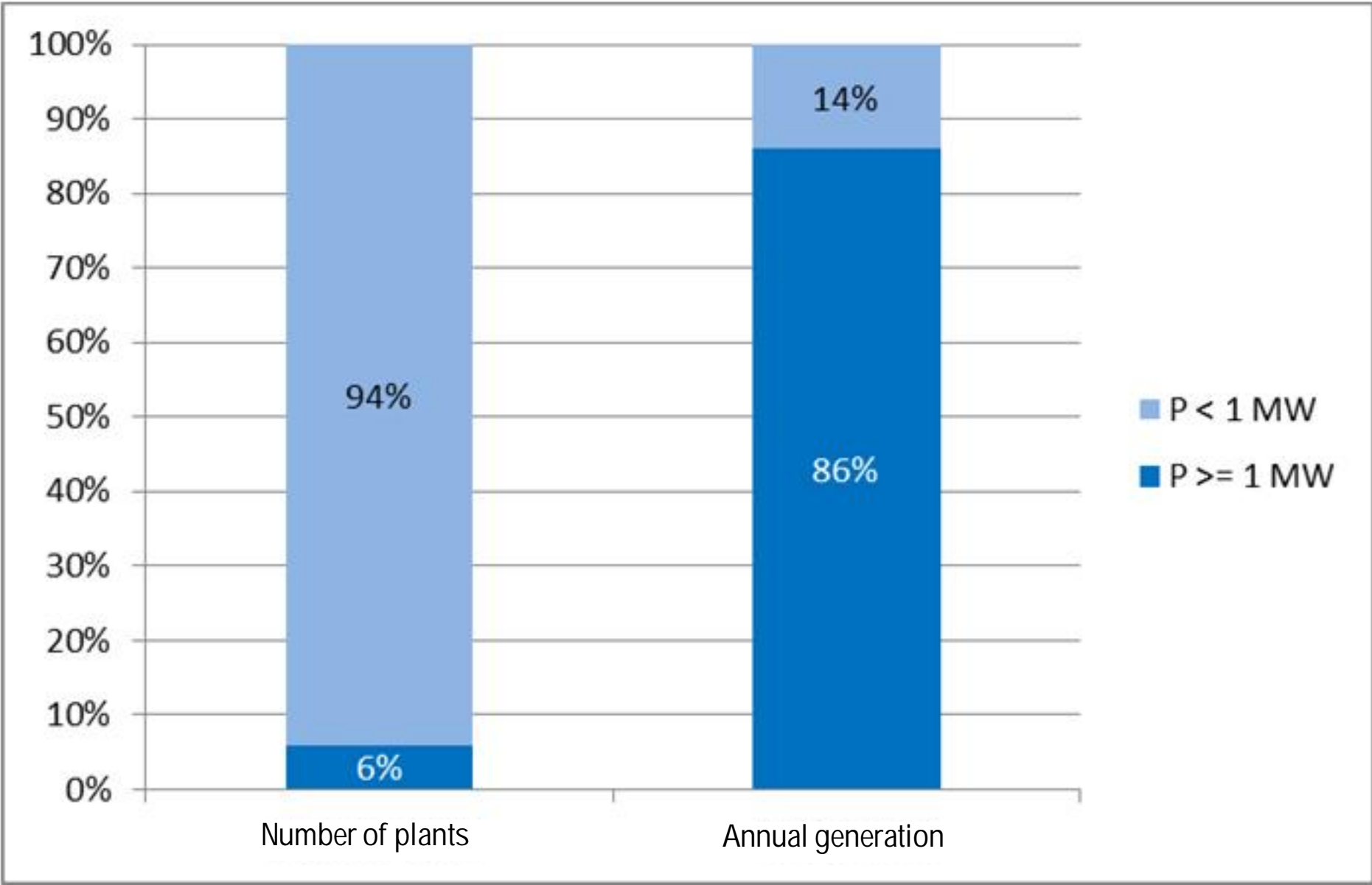
P_{EEG} up to	Feed-in tariff ct/kWh
500 kW	12,40
2 MW	8,17
5 MW	6,25
10 MW	5,48
20 MW	5,29
50 MW	4,24
ab 50 MW	3,47

- ▶ Requirement
 - ▶ Increase of power capacity (technical measures)
 - ▶ Upgrading measures which require authorisation (ecological measures)

► Electricity production costs



Number and annual generation of HPP in Germany (in 2013)



Fish protection at large HPP ($Q \gg 100 \text{ m}^3/\text{s}$): No state of technology



- ▶ Protection screens
 - ▶ Unrealisable
- ▶ Fish friendly turbines
 - ▶ Lack of practical experience
- ▶ Eel friendly operation
 - ▶ Species-specific

Can the legal requirements be met by hydropower plants?

- ▶ Small HPP: uneconomical
- ▶ Large HPP: lack of adequate technology

Thank you for your attention

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