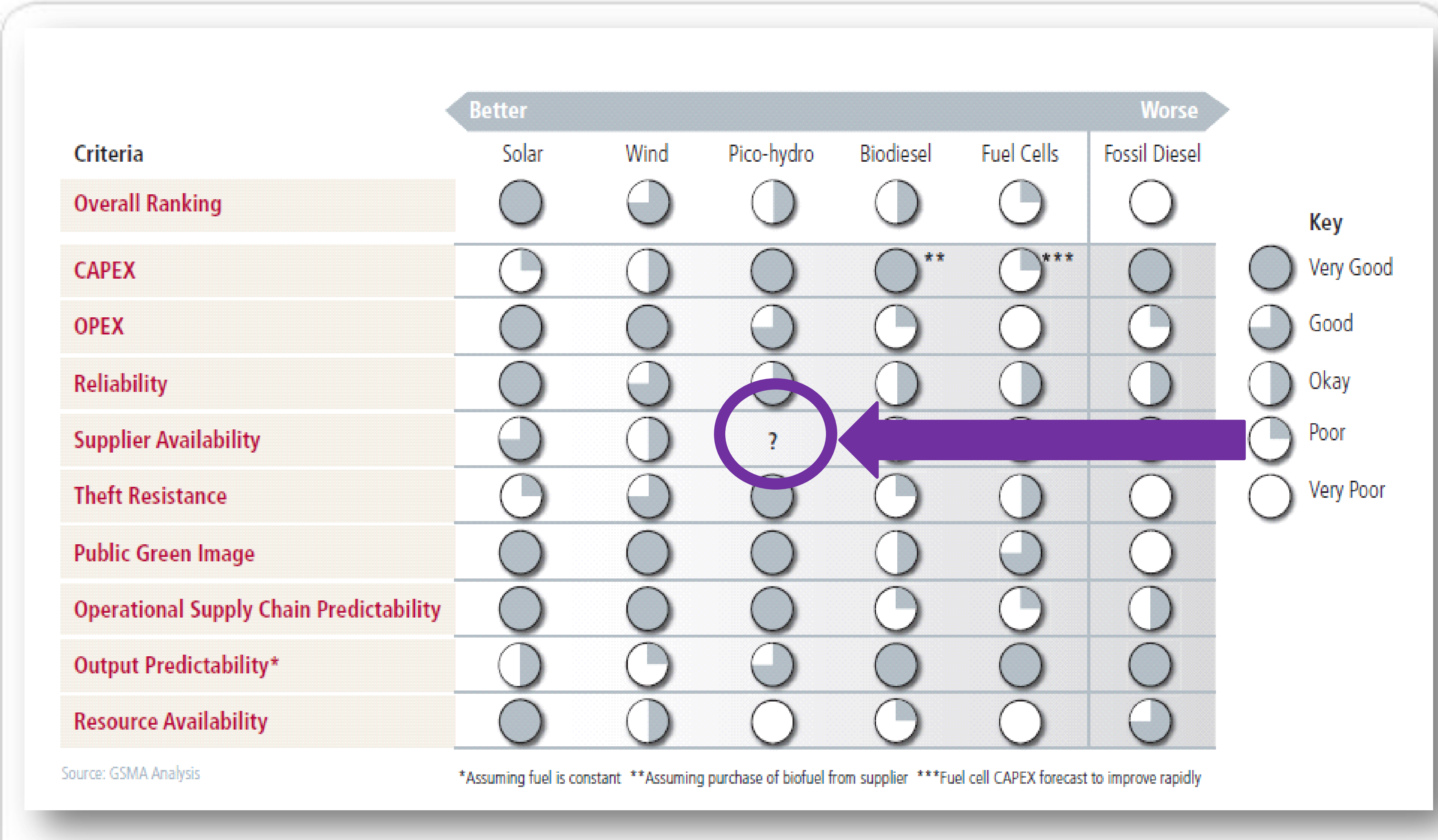
Kinetic Micro Hydro for Telecommunication Sites

Agenda

- Pico hydropower as alternative source for remote cell sites
- Smart Hydro Power Product Description
- Business Case
  - Diesel
  - Grid injection
- Usage Case
- Site Analysis
- Market Potential
- Status Smart Hydro Power & next steps

GSMA analysis with positive result for pico hydro – but lack of suppliers



Hydropower is baseload energy

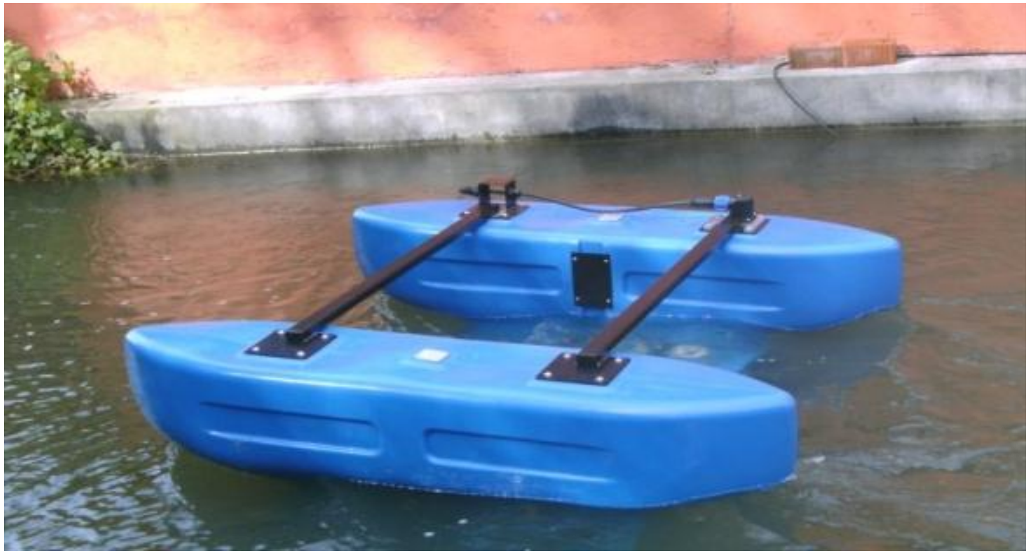
Technology	Usage hours India*	Usage hours Germany*
Photovoltaic	2,500 h	800 h
Wind power	3,500 h	2,500 h
Hydropower	8,300 h	8,300 h

* Typical sites, strong variation

First standardized 5 kW turbine designed for off-grid applications

- Complete Unit (plug & play)
- 340 kg weight allows easy installation
- Robust, industrial assembling
- Adaptable to local environment
  - 50 Hz / 60 Hz
  - 110 / 220 Volt
  - Grid injection / isolated grid

Smart kinetic hydropower is environmental friendly…



- No changes to river habitat (no dam, easy removable)
- Water safe materials only
- No noise (Operates quietly)
- Fish friendly due to lack of suction in front of the turbine
- If substituting diesel standardized units fit CDM program approach

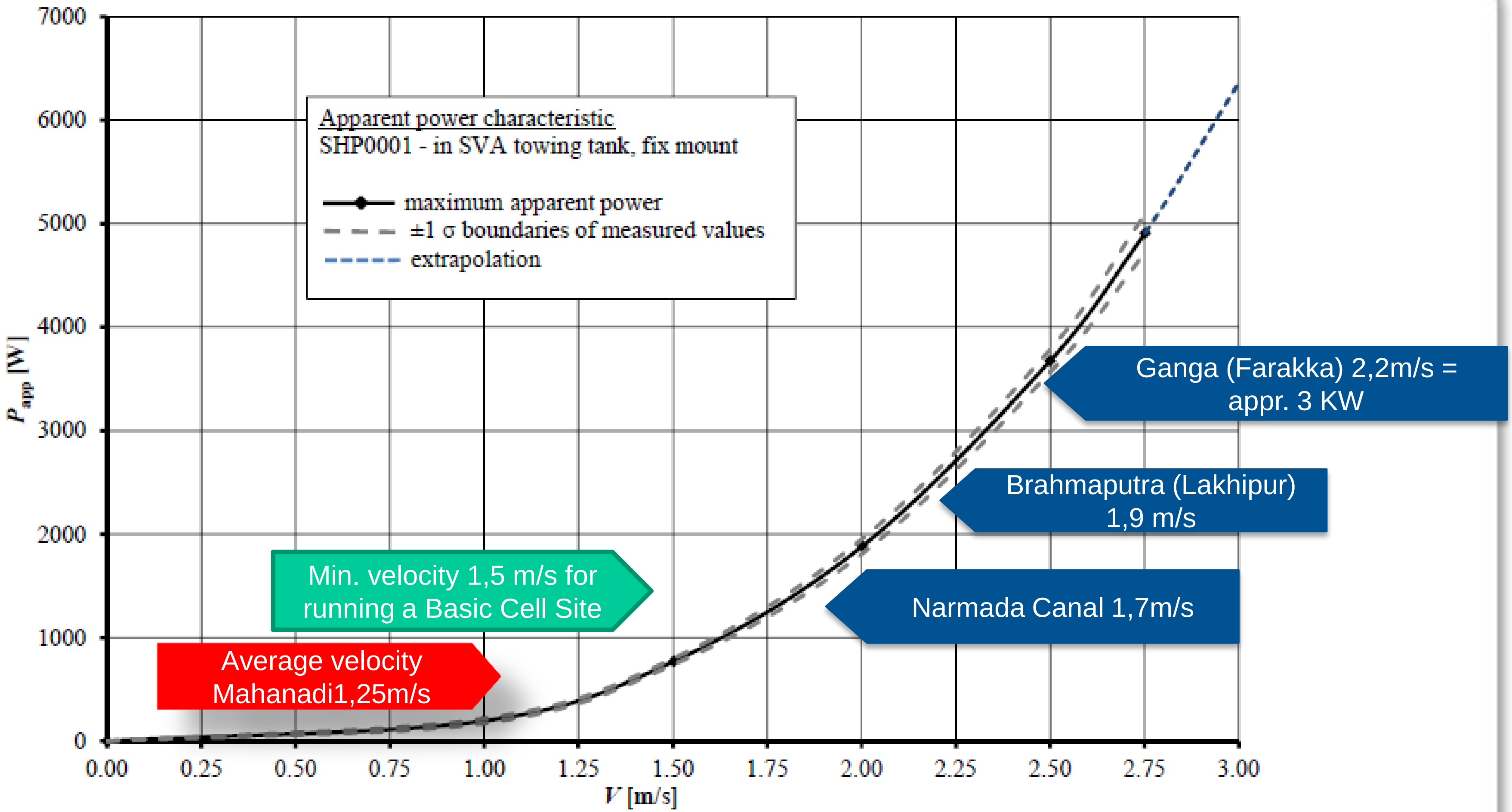
…and easy to handle

Crane

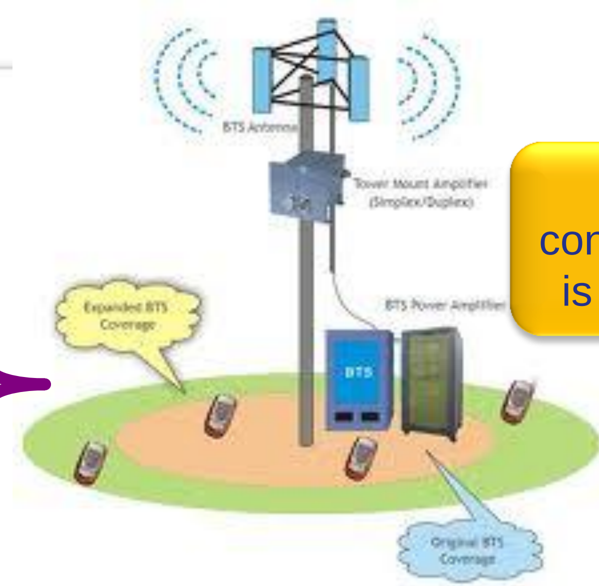
Trailer

Carry

Power output at different speeds



Even low velocities enough for base load supply of small sites



1/1/1 configuration is required

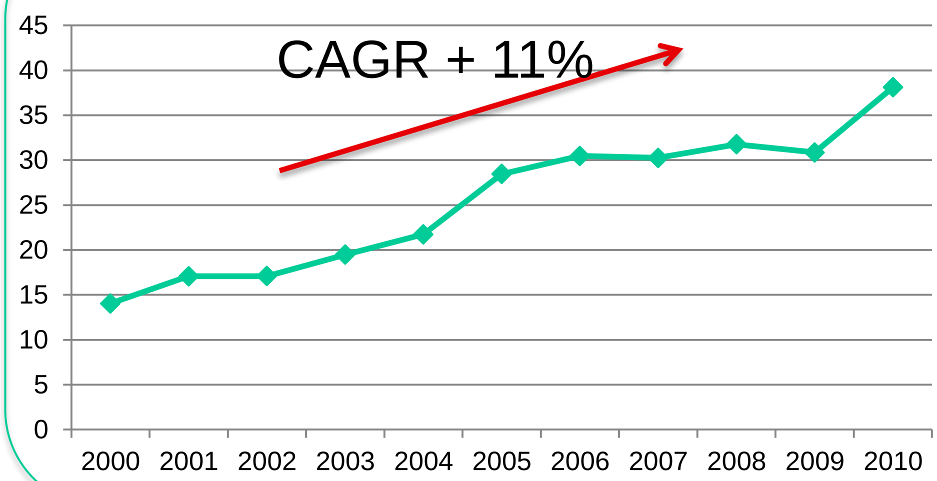
<u>Example:</u>

- Remote RV Park w/o Grid no coverage
- 50 Sites for Campers
- 100 People Friday – Sunday
- 20 calls at the same time.

Case recreational area small: 1/1/1 RRH 20	→	725 W
Additional load MW typical:	→	90 W
Additional load summer/winter (CBU Battery Cooler 12V/ 2V Battery)	→	50/45 W
Total	→	**865 W**

Business case (1): Smart vs diesel

Price Diesel in India (Rupee / l)



Capex	18,000 U$
Amortisation period	5 years
Life cycle	10 years
Opex (p.y.)	500 U$
Usage hours	8,300 h

$kWh_{electric}$ from diesel genset

Diesel	0.73 U$ / l
Transport (x50%)	0.37 U$ / l
Total	1.10 U$ / l
Electric efficiency	30%

= 0,37 U$ / kWh_{el}

1,0 kW	0,50 U$ / kWh
1.5 kW	0,33 U$ / kWh
2.0 kW	0,25 U$ / kWh
3,0 kW	0,17 U$ / kWh
5,0 kW	0,10 U$ / kWh

Business case (2): Smart to the grid

Capex	16,500 U$
Amortisation period	10 years
Life cycle	10 years
Opex	750 U$
Usage hours	8300 h
Annual costs	2400 U$

Power output	kWh generated	Specific cost
1 kW	8,300 kWh	0,28 U$ / kWh
1,5 kW	12,000 kWh	0,20 U$ / kWh
2 kW	16,000 kWh	0,15 U$ / kWh
3 kW	24,000 kWh	0,10 U$ / kWh
5 kW	41,000 kWh	0,05 U$ / kWh

Feed-in tariff

India (PV)

0,17 U$/kWh

(average bid price 2012)

Huge market potential India

River name	BCM(Billion cubic meters)/Ann	Average Flow m3/sec+	Place of measurement*	Height (m)*	Width (m)#	Average linear flow (m/s)
Ganga	250,00	7927,447996	Farakka barrage	3,5	1106	2,05
Brahmaputra	240,00	7610,350076	Lakhipur	5	805	1,89
Godavari	76,30	2419,457128	Polavaram	8,5	186	1,53
Krishna	58,00	1839,167935	Dameracherla	7,5	137	1,79
Cauvery	19,00	602,4860477	Menaangudi	3	125	1,61
Mahanadi	49,99	1585,172501	Basantpur	7,5	168	1,26
Narmada	34,50	1093,987823	Koyali	6	146	1,25
Tapi	14,50	459,7919838	Sinor	4	118	0,97
Indus (up to Border)	46,00	1458,650431	NA			

Rivers to be used for Power generation

- Source: own analysis based on water related statistics(central water commision)+ Integrated Hydrological data book 2009* Google earth

Status and next steps

Installed Turbines

- Auermühlbach, Munich, Germany
- Hoyobamba, San Martin, Peru
- Elbe, Wittenberge, Germany
- Canal Perlen Papier AG, Perlen, Switzerland

Current Planning

- Rhine, Bingen, Germany, modular 80 kW power plant
- Kaptai Dam, Chittagong, Bangladesh, modular >100 kW plant
- Rhine, Bonn, Germany
- Papua, Indonesia

Future Projects

- Telecommunication towers?

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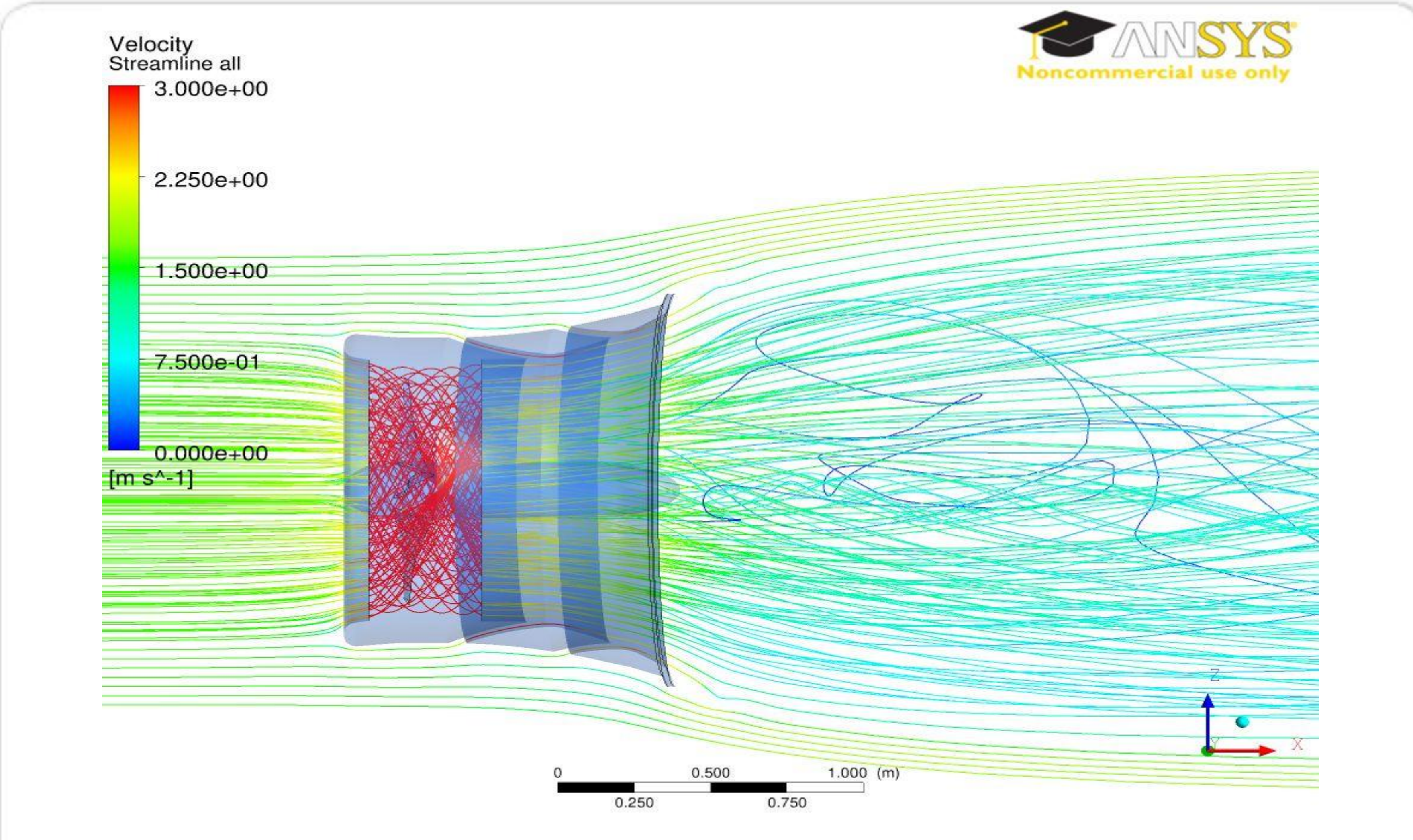
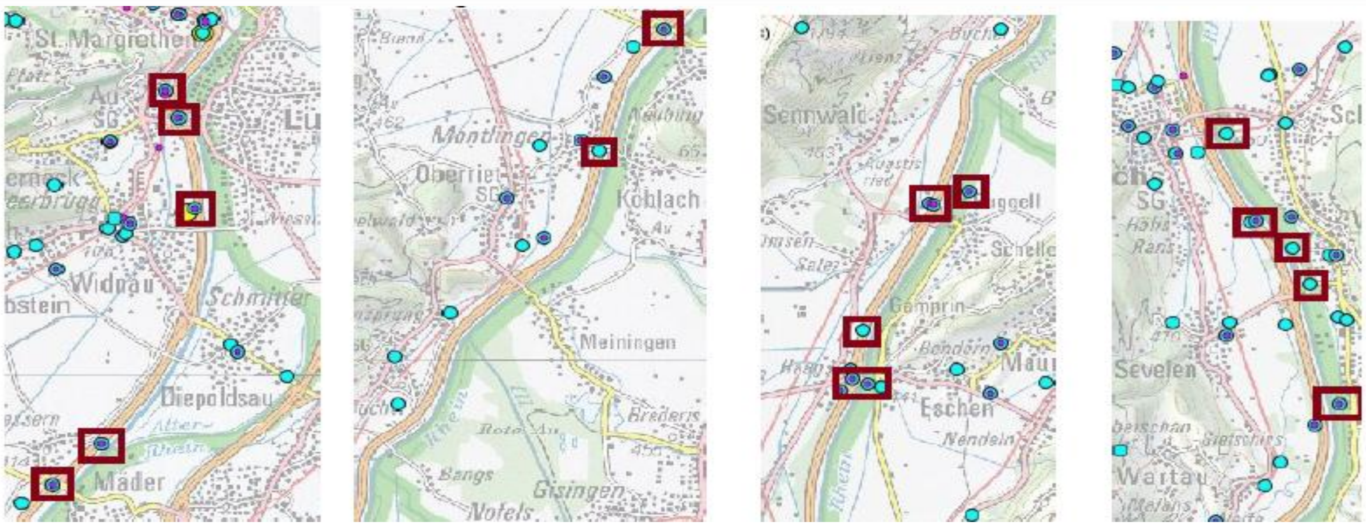


Backup

How to find the appropriate sites

- Identify rivers with velocity > 1.5 m/s
- Match with existing / planned cell sites
- Match current demand / supply potential
- Shape demand curve if possible / needed
- Find customer for excess energy

Example II – Swiss: Survey of potential cellsites for grid connection



Summary:

- Cell sites within 200m next to the river could be powered by hydro turbine
- It is possible to locate cell sites near the river

Business model:

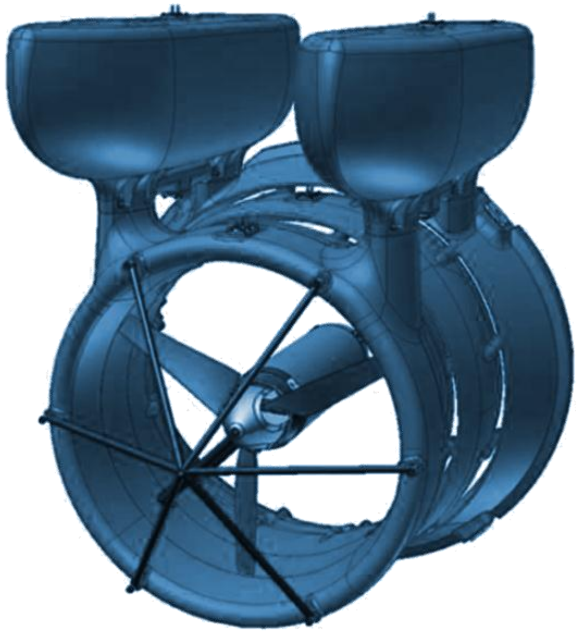
- Operator could be interested to use cell sites for getting the feed in tariff / Cell sites can be utilized as an connection point toward the grid

Source: http://www.bakom.admin.ch/themen/frequenzen/00652/00699/index.htm

Basic Technical Overview

Physical Characteristics

- Weight: 340 kg
- Dimension: 1470x1740x1970 (LxWxH)
- Rotor diameter: ø1000mm
- Rotational Speed: 90 to 230 rpm (nominal)



Electrical Specifications

- Max Output Power: 5kW
- Electrical Rating: 5kVA
- Output Voltages: 230V /118V AC (24V DC possible)
- Operating Frequency (AC): 50Hz/60Hz
- Generator: Permanent Magnet Synchronous AC

River Specifications

- Min depth 2 m
- Recommended velocity > 1,5 m / s, < 3,5 m / s

Certifications

Available Now

EU - CE:

- EN ISO 12100 2010: Safety of machines
- DIN EN 60204-1 206 + A1 2009: low voltage regulation
- EN 1037: 1995 + A1 2008: Safety of machines
- EN 349 1993 + A1 2008: Protection of human damages

EN ISO 13857 2008: Safety of machines

EN 953 1997 + A1 2009: Safety machines

EMC:

- EN 61000-3-12:2005
- EN 61000-6-1:2007
- EN 61000-6-4:2007

Planned for 2013

USA - UL:

- UL 1004 P 1+4
- UL 1741
- UL 1283

Field Evaluation USA:

- NFPA 70
- NFPA 79
- UL 508a

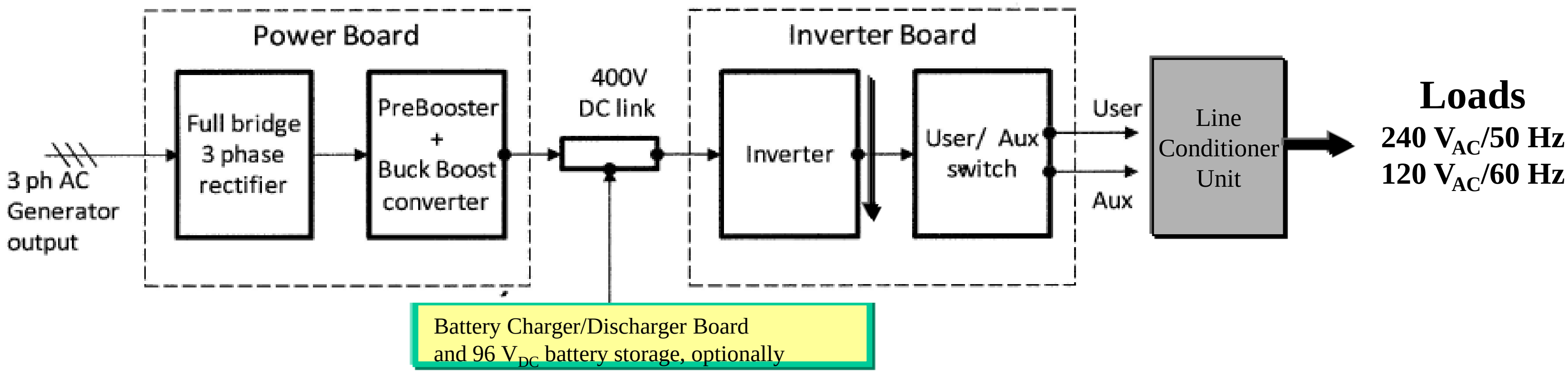
Canada:

- C22.2.N6 100-04 (R2009): Motors and Generators
- C22.1-09: Canadian Electrical Code

Field Evaluation Canada:

- CSA SPE 1000 09: Code for Field Evaluation of el. equip.
- C22 NO 257-06 (R2011): Interconnecting Inverter based..

System Architecture of EMS



Optional approach DC feed in:
(to be designed later)

Replacement of Inverter Board by 400V_{DC} to 48 V_{DC} Buck Converter