REPIC Wissensgemeinschaft Minigrid

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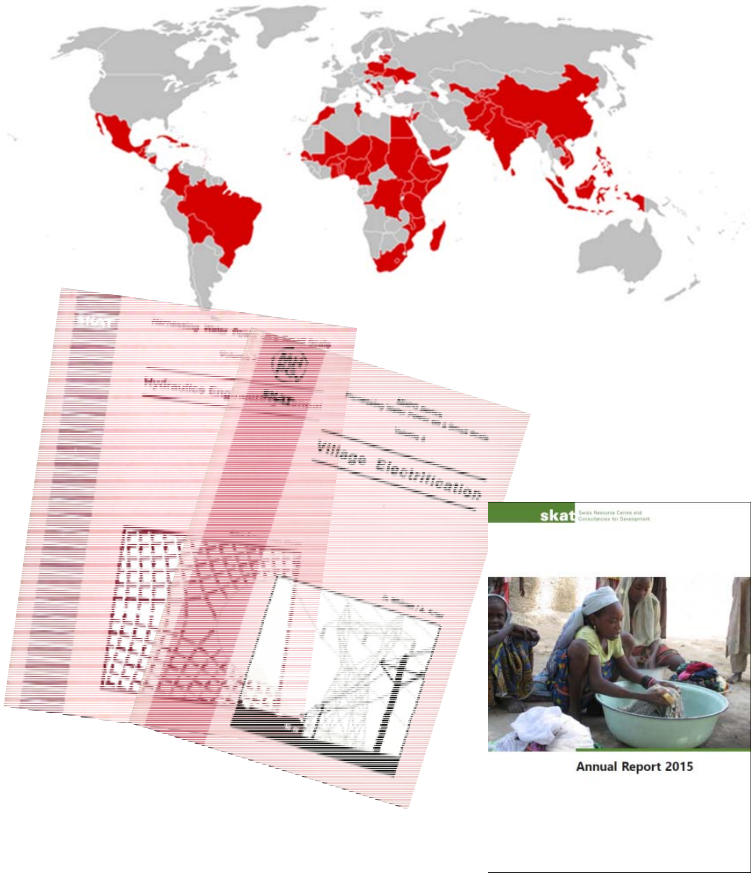
- Minigrids / Inselversorgungen: Einführung, Übersicht an Beispielen der Kleinwasserkraft
- Geeignete Technologien und Kombinationen
- Welche Kombinationen für welche Länder?

Über die Skat

- Gegründet 1978 als «Schweizerische Koordinationsstelle für Angepasste Technologie»
- Fokusthemen: Water & Sanitation, Architecture and construction, Transport Infrastructure, Energy & Climate
- 1998: Umwandlung in eine Aktiengesellschaft, «Swiss Centre for Development Cooperation in Technology and Management».
- 2001: Gründung der Skat Foundation
- Heute: 27 Mitarbeiter



Vergleich Netzeinspeisung – Inselsystem (Minigrid)

Grid connected

- Maximum utilisation of the available potential
- Low generation costs
- Tariff agreed with utility
- Plant factor limited by the availability of the natural ressources / fuel (MHP: typically 50…60%)

Isolated system (“Minigrid”)

- Low utilisation of the available potential, limited power capacity
- Higher generation costs
- Tariff depends on the acceptance of the end users
- Plant factor limited by the demand (typically 15…30%)
  - Higher with batteries
- Can rarely be implemented on a commercial basis → often grant financed
- Can become a “cash cow” for the community if later on connected to national grid (feed-in)

Isolated systems (off grid / Minigrid)

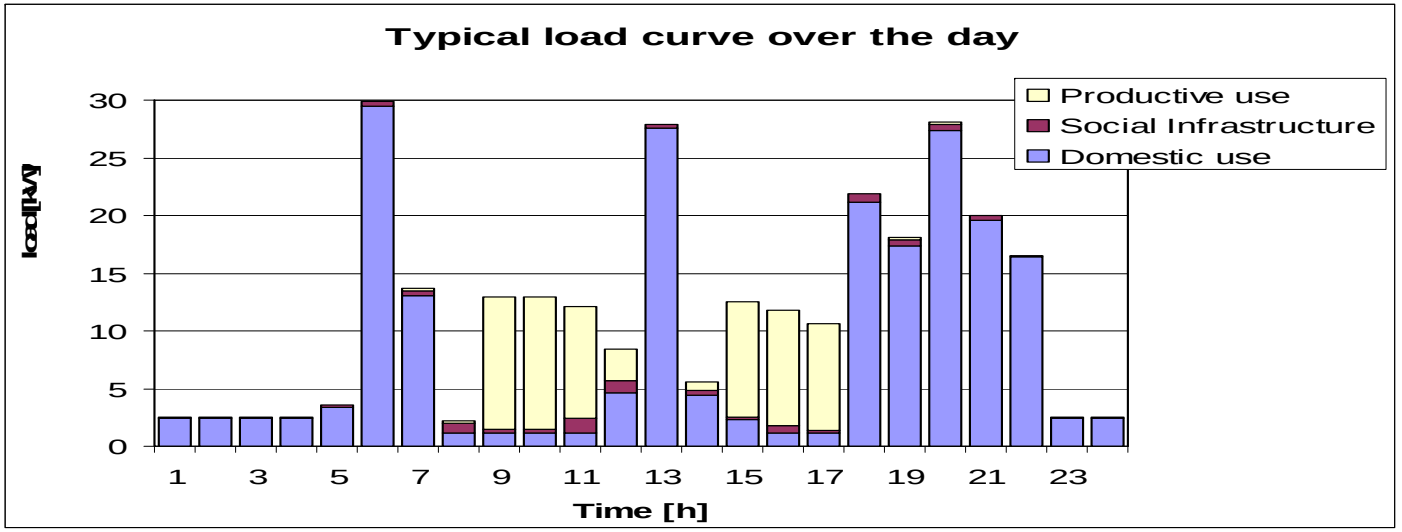
- Small remote villages, far from national grid
  - High costs for grid extension
  - Low consumer density
  - Low electricity consumption
  - → grid connection: hardly cost-effective
- But: Often high opportunity costs for other energy sources like candles, kerosene, diesel, etc.
- Isolated systems may produce energy at lower costs and allow for additional income possibilities
  - Energy for productive use (agro processing: milling, threshing, hulling etc.), water pumping, etc.
  - Fridges for food conservation and safekeeping of pharmaceuticals

Demand Forecast

- domestic consumption
  - Light, TV, Radio, fridge…
- consumption of social infrastructure (public and service consumption):
  - schools, health centers, mosques / churches, street lighting, administration etc.
- productive use
  - milling and other agricultural processing, kiosks, welding and carpentry workshops, etc.)

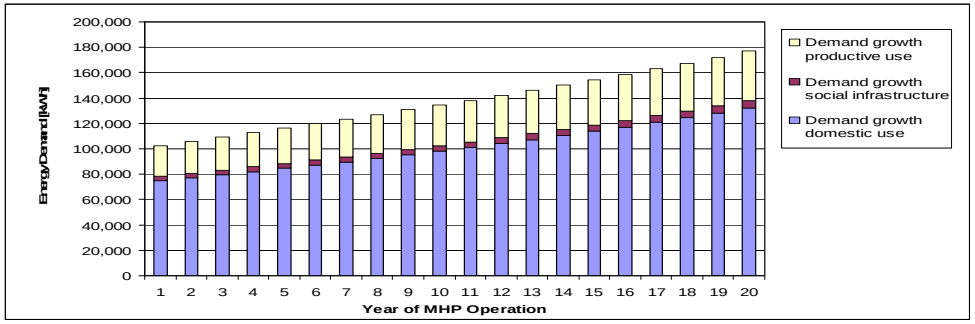
Total demand – daily load curve

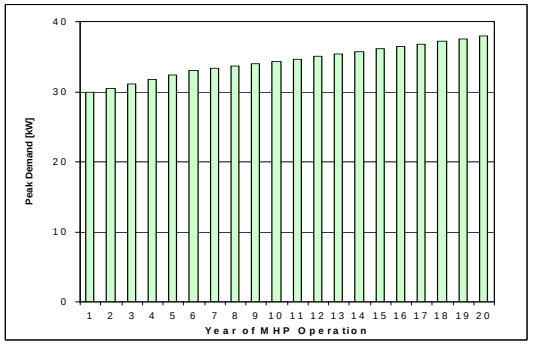
	consumption [kWh] during every hour of the day																								demand [kWh]		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	daily	monthly	yearly
Domestic use	2.4	2.4	2.4	2.4	3.4	**29.5**	13.1	1.2	1.2	1.2	1.2	4.7	27.6	4.5	2.3	1.2	1.2	21.2	17.3	27.4	19.6	16.4	2.4	2.4	208	6,253	75,032
Social Infrastructure	0.1	0.1	0.1	0.1	0.3	0.4	0.4	0.8	0.3	0.3	**1.2**	1.0	0.4	0.4	0.2	0.6	0.2	0.7	0.5	0.5	0.4	0.1	0.1	0.1	9	279	3,350
Productive use	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	11.5	**11.5**	9.8	2.8	0.0	0.8	10.0	10.0	9.3	0.0	0.2	0.2	0.0	0.0	0.0	0.0	66	1,989	23,868
Total daily demand	3	3	3	3	4	**30**	14	2	13	13	12	8	28	6	13	12	11	22	18	28	20	17	3	3	284	8,521	102,250



Projection of demand growth

Year of operation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Domestic use																					
Growth rate demand per houshold		2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Demand per household	750	765	781	796	812	828	845	862	879	897	915	933	952	971	990	1,010	1,030	1,051	1,072	1,093	kWh
Growth rate number of households		1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Number of households	100	101	102	103	104	105	106	107	108	109	110	112	113	114	115	116	117	118	120	121	HH
Demand growth domestic use	75,032	77,298	79,632	82,037	84,515	87,067	89,697	92,406	95,196	98,071	101,033	104,084	107,227	110,466	113,802	117,239	120,779	124,427	128,184	132,055	kWh
Social Infrastructure																					
Growth rate social infrastructure		3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	
Demand growth social infrastructure	3,350	3,450	3,554	3,660	3,770	3,883	4,000	4,120	4,243	4,371	4,502	4,637	4,776	4,919	5,067	5,219	5,375	5,537	5,703	5,874	kWh
Productive end use																					
Growth rate productive use		5%	5%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Demand growth productive use	23,868	25,061	26,314	27,104	27,917	28,755	29,617	30,506	31,421	32,049	32,690	33,344	34,011	34,691	35,385	36,093	36,815	37,551	38,302	39,068	kWh
Total demand	102,250	105,810	109,501	112,802	116,202	119,705	123,314	127,031	130,860	134,491	138,225	142,065	146,014	150,076	154,254	158,550	162,969	167,514	172,189	176,997	kWh
Year of operation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Peak demand																					
Growth rate		2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Peak demand growth	**30**	31	31	32	32	33	33	34	34	34	35	35	35	36	36	36	37	37	38	38	kW





Summary on the forecast

	year 1	year 20
number of hh's	100	121
monthly hh consumption [kWh/month]	63	91
total monthly demand of all hh [kWh/month]	6,253	11,005
monthly consumption of social infrastructure [kWh/month]	279	489
monthly productive consumption [kWh/month]	1,989	3,256
total peak load [kW]	30	38

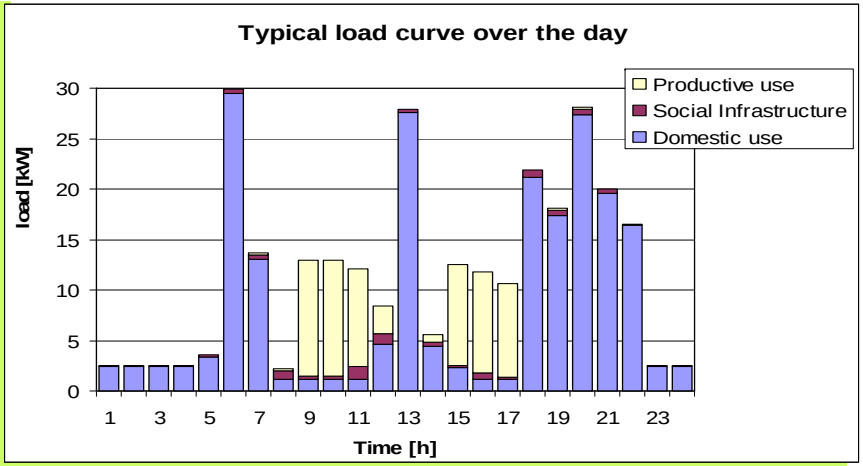
revenues → cash flow

system design

Load and demand side management

Reduce peaks and / or demand by:

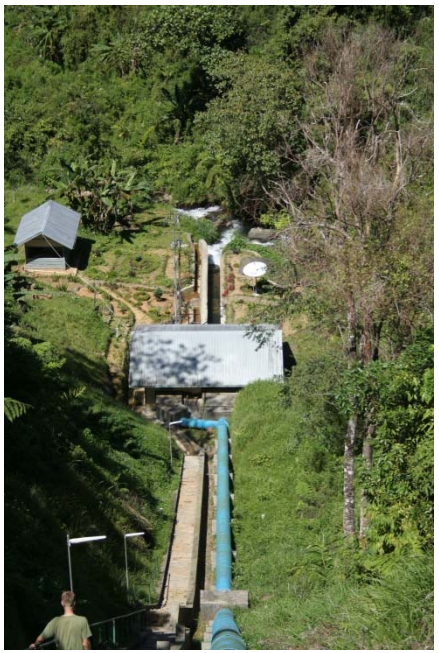
- Sensitising consumers / awareness raising (energy saving bulbs, promotion of productive end use etc.)
- Creating special tariff system, e.g. combined with installation of current limiters…
- Load shedding



More continuous demand:

- Promotion of productive use during morning / afternoon
- For example water pumping / irrigation at night
- Installation of storage systems (batteries, reservoirs)

Eignung verschiedener Technologien für Mini-Grids: Kleinwasserkraft



- Verfügbarkeit Wasserkraftpotenzial, ganzjährig? Distanz Kraftwerk – Konsumenten?
- Komplexe Planung, einfache Komponenten: Wartung und Betrieb durch lokales, geschultes Personal möglich
  - Geringe Betriebskosten – hohe Investition
- Konflikte Wassernutzung (Landwirtschaft, Ökologie, Gesellschaft, …)?
- Umrüstung auf Netzeinspeisung einfach möglich und sinnvoll
- → Anwendung in Ländern mit regelmässigen Niederschlägen und geeignetem (hügeligen) Gelände
  - Beispiele: Kamerun, Äthiopien, Kolumbien, Peru, Indonesien, Vietnam, Nepal, …

Sinnvolle Kombinationen

Sinnvoll: Komplementäre Kombinationen

- Bspw. Kleinwasserkraft + Diesel:
  - geringe Investitionskosten für das Dieselaggregat
  - Diesel nur für höhere Maximalleistung (Peak demand) und zur Überbrückung von Trockenzeiten

Besten Dank für Ihre Aufmerksamkeit!

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