Energy Efficiency Program Evaluation and MCA
Answers to assignment

1. Cost effectiveness *(22 points)*

1a) Cost effectiveness of natural replacement of broken system **(8 points)**

Results for energy price of 45 CHF/GJ

Question 1a): Replacement of old broken system

Heating system		Investment cost	Energy demand	Investment cost difference (new)	E savings (new)	Benefit, i.e. energy cost savings (new)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF/yr	CHF/GJ
H1	old	55000	2200				
H2	standard	60000	2100				
H3	efficient	110000	1800	50000	300	13500	-23.9

Circulation pump		Investment cost	Energy demand	Investment cost (new)	E savings (new)	Benefit, i.e. energy cost savings (new)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF/yr	CHF/GJ
CP1	old	18500	1510				
CP2	standard	21500	1470				
CP3	efficient	30500	1440	9000	30	1350	-7.0

*) Levelized cost

1b) Cost effectiveness for lower energy price of 20 CHF/GJ (otherwise same as 1a) **(2 points)**

Results for energy price of 20 CHF/GJ

Question 1b) for Replacement of old broken system

Heating system		Investment cost	Energy demand	Investment cost difference (new)	E savings (new)	Benefit, i.e. energy cost savings (new)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF/yr	CHF/GJ
H1	old	55000	2200				
H2	standard	60000	2100				
H3	efficient	110000	1800	50000	300	6000	1.1

Circulation pump		Investment cost	Energy demand	Investment cost (new)	E savings (new)	Benefit, i.e. energy cost savings (new)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF/yr	CHF/GJ
CP1	old	18500	1510				
CP2	standard	21500	1470				
CP3	efficient	30500	1440	9000	30	600	18.0

*) Levelized cost

1c) Retrofit (Early replacement) **(6 points)**

Results for energy price of 45 CHF/GJ

Question 1c): Early replacement

Heating system		Investment cost	Energy demand	Investment cost difference (retrofit)	E savings (retrofit)	Benefit, i.e. energy cost savings (retrofit)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF	CHF/GJ
H1	old	55000	2200				
H2	standard	60000	2100				
H3	efficient	110000	1800	83846	362	16269	-15.7

Circulation pump		Investment cost	Energy demand	Investment cost (retrofit)	E savings (retrofit)	Benefit, i.e. energy cost savings (retrofit)	Cost effectiveness (new) *)
		CHF	GJ/yr	CHF	GJ/yr	CHF	CHF/GJ
CP1	old	18500	1510				
CP2	standard	21500	1470				
CP3	efficient	30500	1440	20385	55	2458	2.2

1 d) (2 points)

The replacement of both heating system as well as the circulation pumps is cost effective when carried out after the technical lifetime (replacement of broken system). In case of an early replacement, the replacement of the heating system remains economically viable while the replacement of the circulation pump becomes economically unviable.

1 e) (2 points)

Expected necessary energy price increase = 73%

1f) (2 points)

Answer will be discussed in the feedback session.

2. Conducting cost-benefit analysis of energy efficiency programmes (*15 points*)

2a) (3 points)
18.5 TJ

2b) (2 points)
The total savings are 20.5 TJ per year. Additional savings are 2 TJ per year.

2c) (2 points)
93.75 k€ over the entire period

2d) (2 points)
11.25 k€ over the entire period

2e) (2 points)
Free rider effect = (subsidies for investments that would have been taken anyway)/ total subsidies. Free rider effect = 82500/93750 = 88%

2f) (2 points)
Cost-effectiveness = $\alpha.I/\Delta E$ = 0.13 * 93.75 (k€) / (20.5-1085) TJ = 6.07 €/GJ (where 1 TJ = 1000 GJ)

2g) (2 points)
The total savings are 22.5 TJ per year. Additional savings are 4 TJ per year; total subsidies 217500 € over the entire period; free rider effect = 76%; cost-effectiveness = 7.04 €/GJ
Note 1:The cost effectiveness of the 50% subsidy scheme is worse than for the 25% subsidy scheme. You could also say that the 50% subsidy scheme has a lower cost effectiveness than for the 25% subsidy scheme; but note that lower cost effectiveness is represented by larger numerical value of the ratio you have calculated.
Note 2:Caution is required when designing government policy in view of the free rider: the total subsidy paid to free riders in the 50% subsidy scheme (165000 €) is much higher than in the 25% subsidy scheme (82500 €).

3. Salient features of the EED *(8 points)*

Answer will be discussed in the feedback session.

4. Multicriteria Analysis (10 points)

Results of the multicriteria analysis are strongly influenced by the choices regarding the weights to be assigned to the different parameters analyzed. Moreover Table 9 and 10 present a range of value for the external cost associated with the environment and the health.

In the following table and diagram the average value of the range was selected for both the external cost associated with the environment and with health.

	Cost/Benefit	Unit	Solar PV	Wind Onshore	Biomass	Natural gas	Weight
LCOE	**Cost**	*$/MWh*	202,94	76,28	72	78,06	0,4
		Normalized	0,00	0,62	0,65	0,62	
		Contribute	0,00	0,25	0,26	0,25	
Environment cost	**Cost**	*c/kWh*	0,162	0,05	0,39	2	0,1
		Normalized	0,92	0,98	0,81	0,00	
		Contribute	0,09	0,10	0,08	0,00	
Health cost	**Cost**	*c/kWh*	0,438	0,101	2,21	0,5	0,1
		Normalized	0,80	0,95	0,00	0,77	
		Contribute	0,08	0,10	0,00	0,08	
Number of employees	**Benefit**	*jobs/GWh*	0,87	0,17	0,21	0,11	0,1
		Normalized	1,00	0,20	0,24	0,13	
		Contribute	0,10	0,02	0,02	0,01	
Social acceptance	**Benefit**		1	1	0,5	0,5	0,3
		Normalized	1	1	0,5	0,5	
		Contribute	0,3	0,3	0,15	0,15	
TOTAL			0,57	0,76	0,51	0,49	1