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MArket uptake of an innovative irrigation Solution based on LOW WATer-ENergy consumption

Economic assessment of large power PV irrigation systems in the ECOWAS region

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No640771

STATE OF THE ART

SMALL POWER PV IRRIGATION SYSTEMS

Advantages

- Plug and play
- Low initial investment

Disadvantages

- Weak water sources
- Power limitation
- Tuning in factory

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LARGE POWER PV IRRIGATION SYSTEMS

Advantages

- Large power
- Reliable water sources
- High efficiency and reliability

Disadvantages

- High initial investment
- On-site tuning

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ECOWAS REGION

- High diesel cost and grid tariff
- Low grid reliability
- Farms far from the grid

IS LARGE POWER PV IRRIGATION FEASIBLE IN ECOWAS REGION?

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ECONOMIC ASSESSMENT

- 7 countries
- 380 kWp on a North-South tracker
- 4 study cases:
  - Pumping to a water pool: substitution of → Diesel / Grid
  - Direct pumping: substitution of → Diesel / Grid
- www.sisifo.info
- Results: NPC, IRR, Payback period, LCoE

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ECONOMIC ASSESSMENT

SCENARIO

Country	EP ($/kWh) [25]	DP ($/l) [26]	t (%) [27]	i' (%) [28]	f (%) [29]	i (%) [23], [24]
Benin	0.23	0.82	9.96	5.6	−0.2	5.8
Burkina Faso	0.25	0.94	16.24	5.6	2.9	2.6
Cape Verde	0.33	0.97	18.26	9.6	−0.9	10.6
Guinea	0.16	0.89	0	4.8	10.6	0
Liberia	0.56	0.83	35.35	13.6	5	8.2
Nigeria	0.20	0.55	17.46	16.9	9.6	6.7
Sierra Leone	0.26	0.78	17.27	18	4.2	13.24

- Ep ($/kWh): electricity price
- DP ($/l): diesel price
- t (%): corporate tax rate
- i' (%): nominal interest rate
- f (%): annual GDP deflator
- i (%): real interest rate

NPC
IRR
Payback period
LCoE

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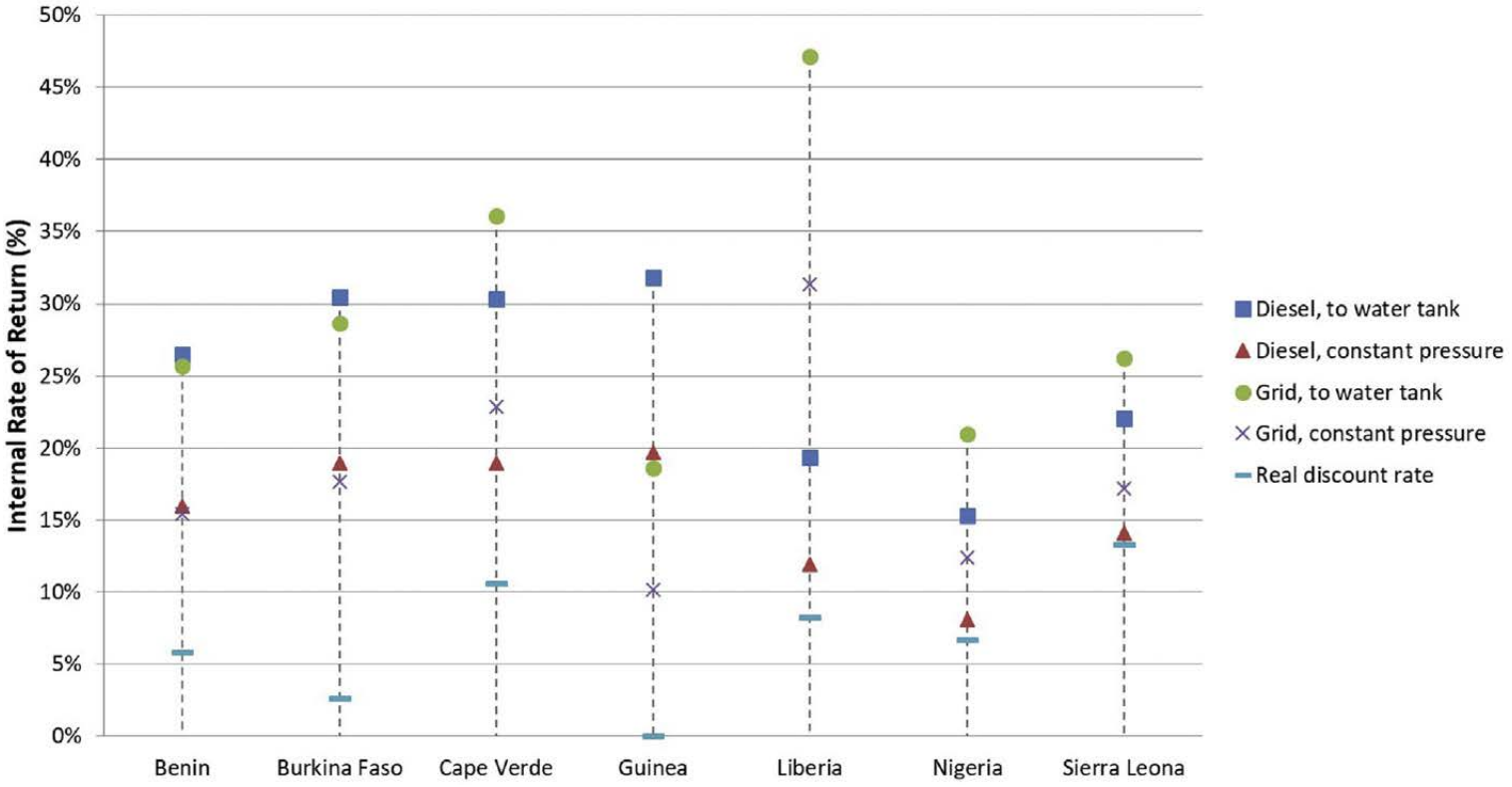
IRR



IRR – water tank

- Diesel: 15 – 32%
- Grid: 19 – 47%

IRR – constant pressure

- Diesel: 8 – 20%
- Grid: 10 – 31%

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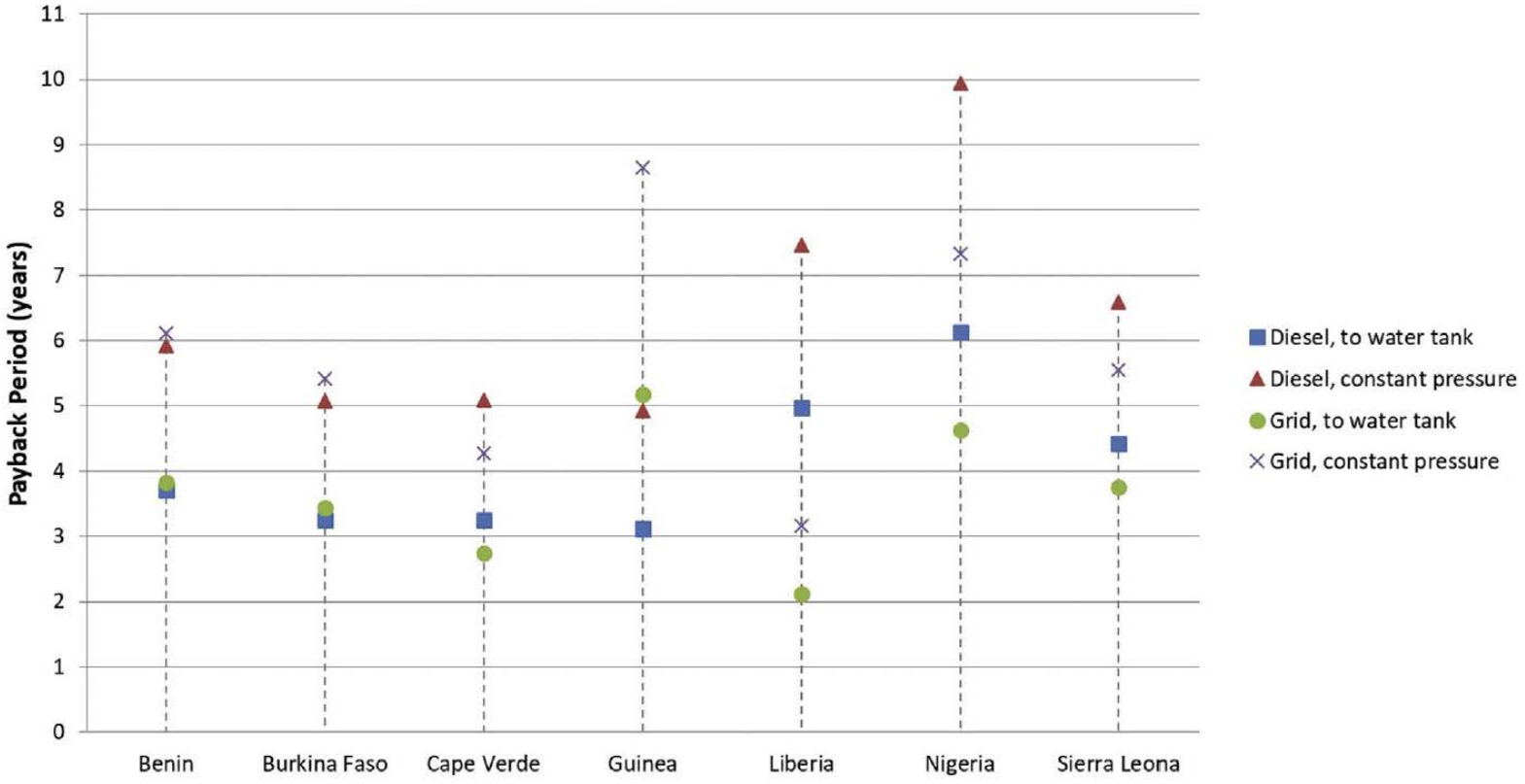
PAYBACK PERIOD



PBP – water tank

- Diesel: 3 - 6 years
- Grid: 2 - 5 years

PBP – constant pressure

- Diesel: 5 - 10 years
- Grid: 3 - 9 years

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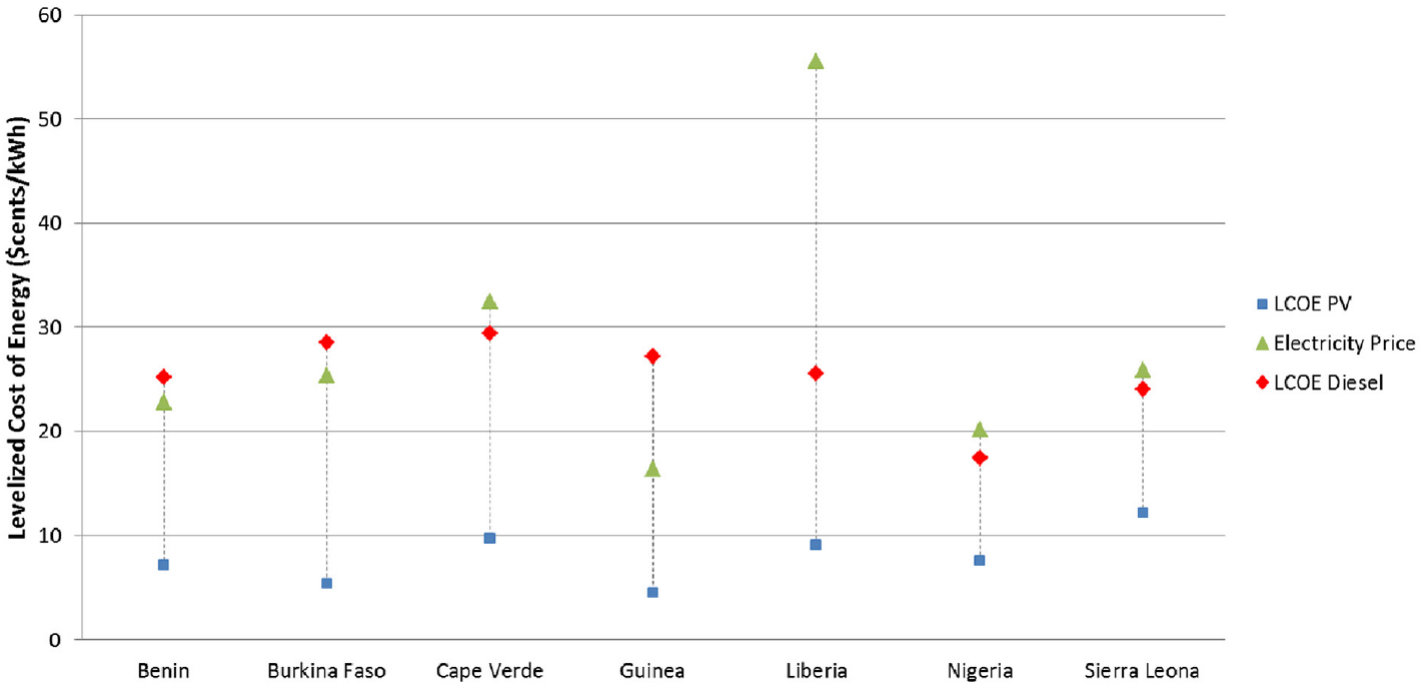
LCoE



LCoE – water tank

- Diesel: 50 – 83% of savings
- Grid: 53 – 84% of savings

LCoE – constant pressure

- Diesel: 30 – 76% of savings
- Grid: 33 – 76% of savings

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SENSITIVITY ANALYSIS

- Diesel cost: ±25%
- Grid cost: ±10%
- PV size: 380, 150, 45 kWp

NPC
IRR
Payback period
LCoE

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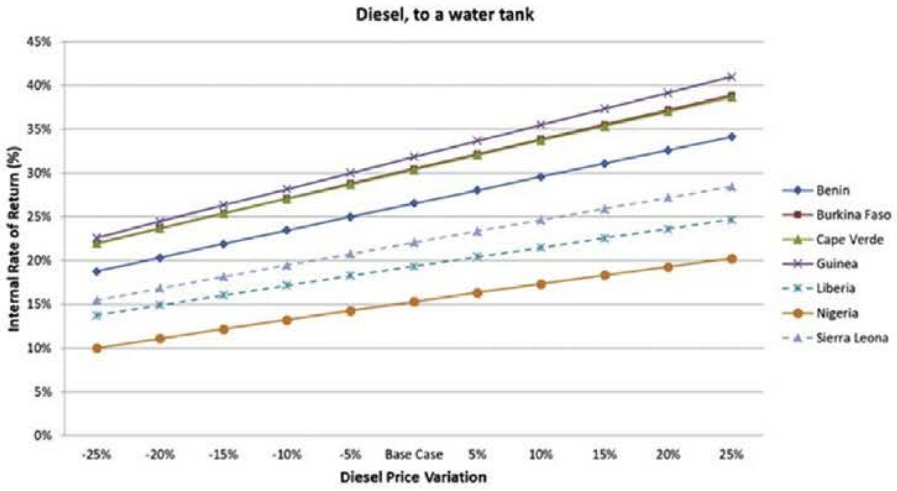
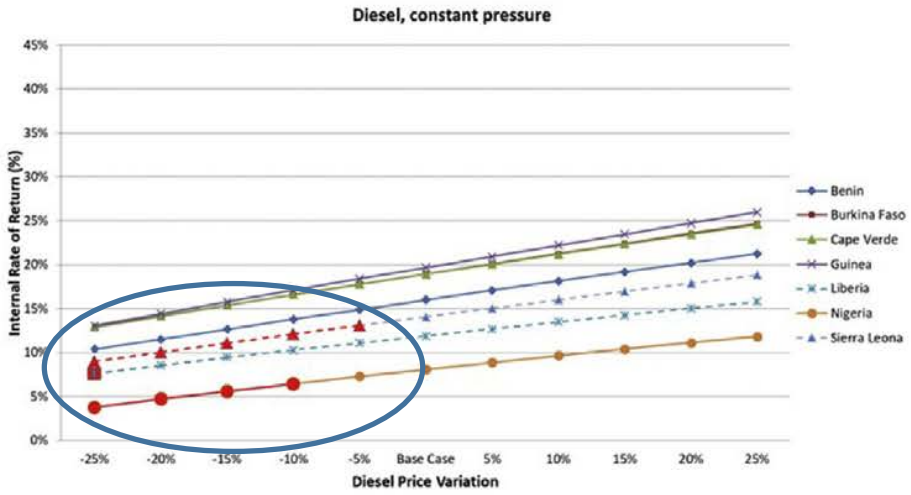
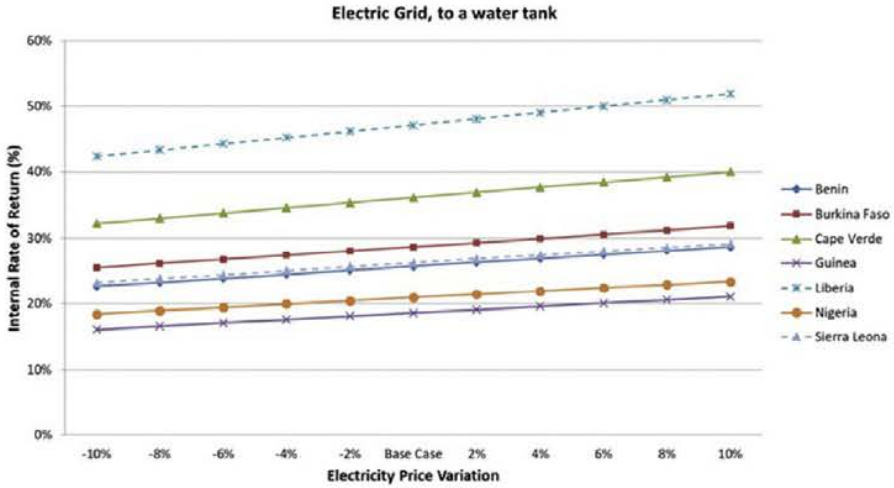
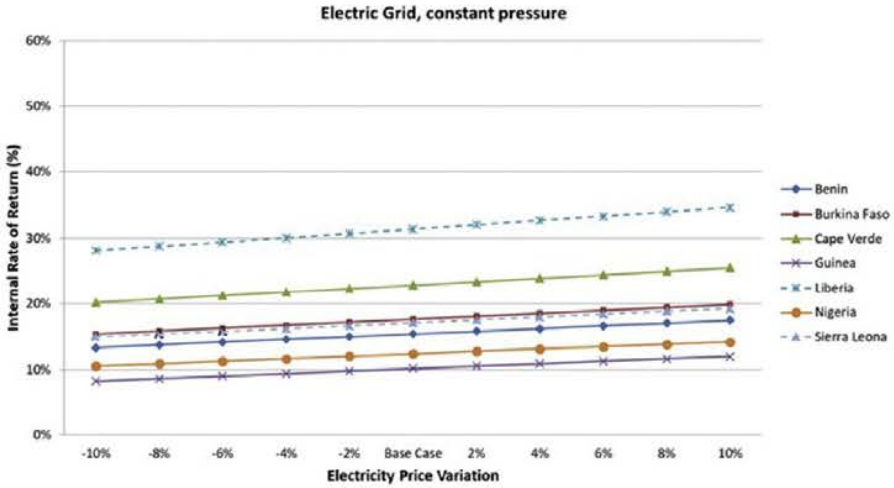
SENSITIVITY ANALYSIS

IRR









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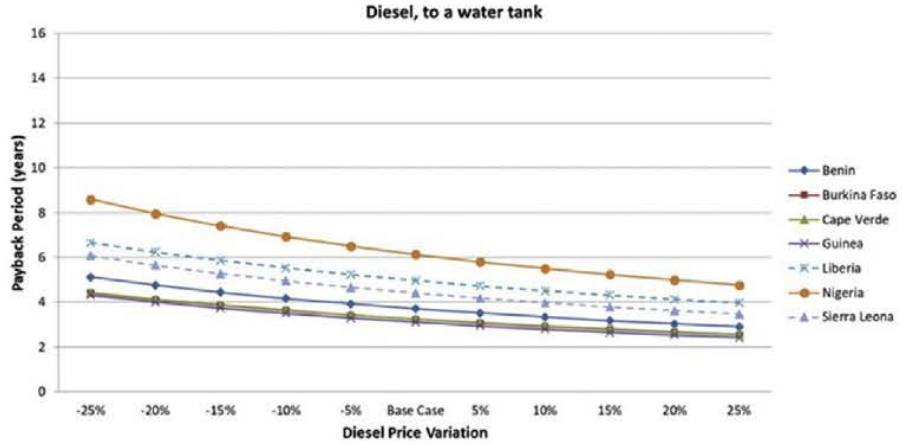
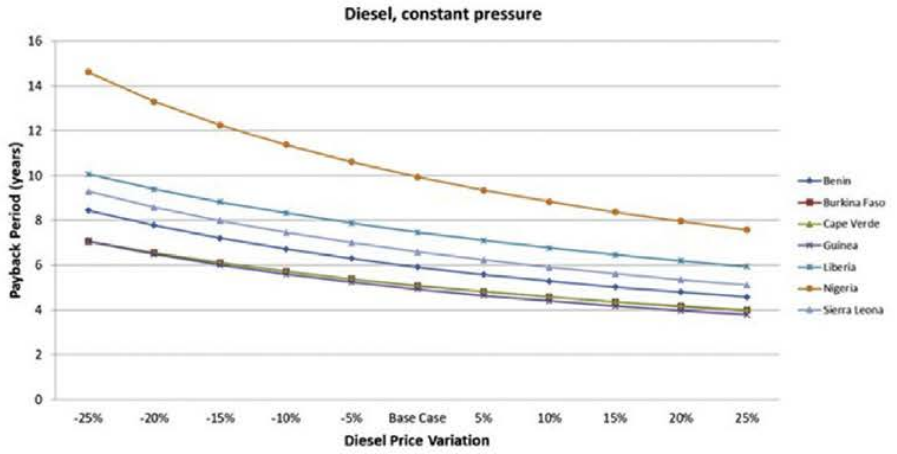
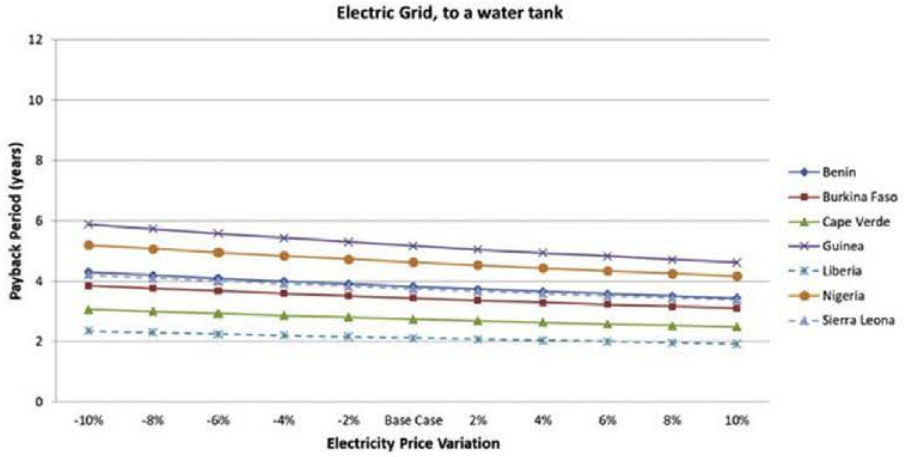
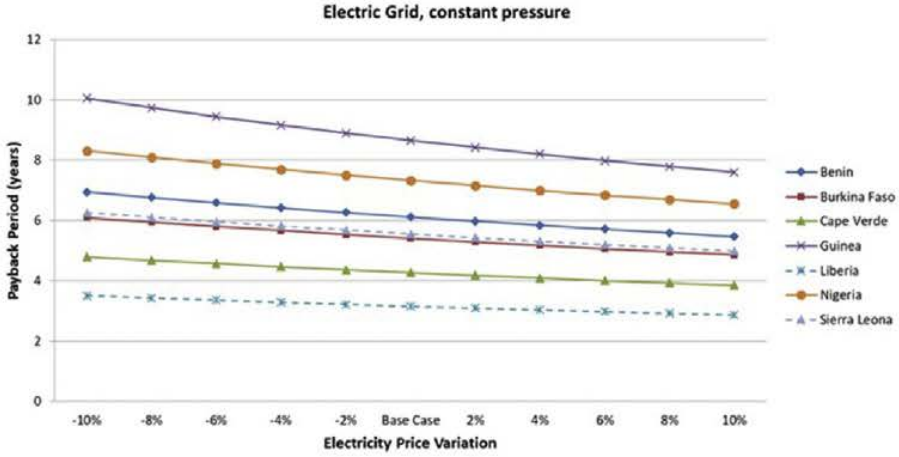
SENSITIVITY ANALYSIS

PBP









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SENSITIVITY ANALYSIS

PV SIZE

kWp	380	150	45
$/Wp	1.7	1.84	2.05

NPC values ($x10^5$$) obtained for the 380 kWp system (columns shadowed in grey) and for the two smaller irrigation systems considered in the sensitivity analysis.

PV Power (kWp)	Diesel, to water tank			Diesel, constant pressure			Grid, to water tank			Grid, constant pressure		
	45	150	380	45	150	380	45	150	380	45	150	380
Benin	1.5	5.6	14.9	0.7	2.6	6.8	1.4	5.3	14.2	0.6	2.4	6.4
Burkina Faso	2.9	10.4	27.0	1.7	5.8	14.7	2.7	9.6	25.1	1.5	5.2	13.4
Cape Verde	1.0	3.7	10.0	0.3	1.4	4.0	1.3	4.9	13.1	0.6	2.2	6.1
Guinea	4.5	16.0	41.5	2.6	9.2	23.7	2.3	8.3	22.2	1.0	4.0	10.7
Liberia	0.6	2.3	6.3	0	0.5	2.0	2.6	9.2	24	1.4	5.1	13.8
Nigeria	0.4	1.8	5.4	−0.1	0.1	0.8	0.9	3.4	9.3	0.3	1.2	3.4
Sierra Leone	0.2	1.2	3.7	−0.2	−0.3	0.3	0.5	1.9	5.5	−0.1	0.2	1.6

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