ΚΕΦΑΛΑΙΟ 6

ΚΕΦΑΛΑΙΟ 6: ΑΞΙΟΛΟΓΗΣΗ ΕΠΕΝΔΥΣΕΩΝ ΣΕ ΥΔΡΟΗΛΕΚΤΡΙΚΑ ΕΡΓΑ ΜΕ ΧΡΗΣΗ ΤΟΥ ΠΡΟΓΡΑΜΜΑΤΟΣ RETSCREEN

6.1 Εισαγωγή

Στο πλαίσιο της περιβαλλοντικής πολιτικής της Ευρωπαϊκής Ένωσης, η παραγωγή ηλεκτρισμού από μικρούς υδροηλεκτρικούς σταθμούς εντάσσεται στις ανανεώσιμες πηγές ενέργειας που εξασφαλίζουν μείωση του ρυπογόνου CO_2 και απεξάρτηση από τις εισαγωγές ενέργειας. Η μεγαλύτερη στροφή, επομένως, προς τις αντιρρυπαντικές τεχνολογίες μειώνει τις οικονομικές επιβαρύνσεις που επιβάλλονται με το Πρωτόκολλο του Κιότο και η ενίσχυσή τους από τους κοινοτικούς και εθνικούς χρηματοδοτικούς μηχανισμούς καθιστά πιο ελκυστικές τις επενδύσεις στις ανανεώσιμες πηγές ενέργειας και ειδικότερα στην υδροηλεκτρική παραγωγή από μικρές μονάδες.

Στο κεφάλαιο αυτό γίνεται αξιολόγηση των επενδυτικών ευκαιριών σε έξι αναπτυσσόμενες ευρωπαϊκές χώρες, σύμφωνα με το πλαίσιο του Μηχανισμού Καθαρής Ανάπτυξης και των Προγραμμάτων Κοινής Εφαρμογής του Πρωτοκόλλου του Κιότο.

Συγκεκριμένα, εξετάζεται η κατασκευή μικρού υδροηλεκτρικού έργου ροής ποταμού, σε διασυνδεδεμένο σύστημα, στις εξής χώρες:

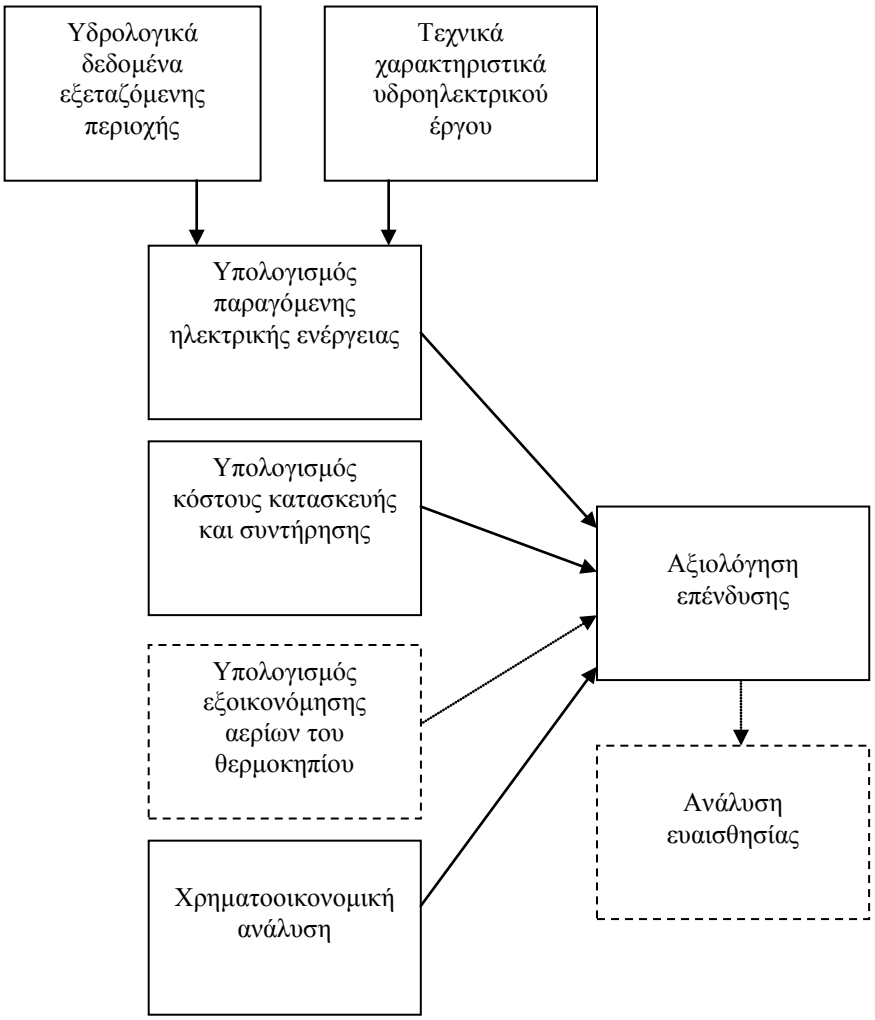
- Αλβανία, Μολδαβία και Πρώην Γιουγκοσλαβική Δημοκρατία της Μακεδονίας, με την αξιοποίηση του Μηχανισμού Καθαρής Ανάπτυξης και
- Βουλγαρία, Ουκρανία και Ρουμανία, με την αξιοποίηση των Προγραμμάτων Κοινής Εφαρμογής,

με την παραδοχή ότι τα κλιματολογικά και οικονομοτεχνικά χαρακτηριστικά είναι κοινά για όλες τις περιπτώσεις.

Στόχος της συγκεκριμένης αξιολόγησης είναι να διαπιστωθεί εάν ο συγκεκριμένος τύπος έργου είναι ευνοϊκός και από οικονομική άποψη και ταυτόχρονα να πραγματοποιηθεί μία σύγκριση μεταξύ των χωρών υποδοχής.

Όπως αναφέρεται στο κεφάλαιο 5, τα φύλλα υπολογισμού του προγράμματος RETScreen είναι τα εξής επτά: Energy Model, Hydrology & Load, Equipment Data, Cost Analysis, GHG Analysis, Financial Summary και Sensitivity. Στο σχήμα 1 που ακολουθεί

παρουσιάζεται επιγραμματικά το διάγραμμα ροής των υπολογισμών που πραγματοποιούνται στα υπολογιστικά φύλλα που προαναφέρθηκαν.



Σχήμα 1: Διάγραμμα ροής των δεδομένων και των υπολογισμών του προγράμματος RETScreen (οι πλήρεις γραμμές υποδεικνύουν υποχρεωτικά πεδία, ενώ οι διακεκομμένες γραμμές υποδεικνύουν προαιρετικά πεδία)

6.2 Χαρακτηριστικά τυπικού υδροηλεκτρικού έργου

Τα χαρακτηριστικά ενός τυπικού υδροηλεκτρικού έργου, στις εξεταζόμενες χώρες, παρουσιάζονται στον πίνακα που ακολουθεί (Πίνακας 1) και αναλύονται στις επόμενες παραγράφους.

Πίνακας 1: Βασικά χαρακτηριστικά τυπικού υδροηλεκτρικού έργου

Ισχύς (€/KW)	2.522
Αρχικό κόστος επένδυσης (€/KW)	4.074
Λειτουργικό κόστος και κόστος συντήρησης (€/KW)	97
Διάρκεια ζωής έργου (years)	30
Εξοικονόμηση ERUs (tCO_2/KW)	3,24

6.2.1 Υπολογισμός παραγόμενης ισχύος και ενέργειας

Πρωταρχικό στοιχείο για την αξιολόγηση της επενδυτικής προσπάθειας με την κατασκευή μικρού υδροηλεκτρικού έργου αποτελεί ο υπολογισμός της παραγόμενης ισχύος και ενέργειας.

Βασικό ρόλο για τους υπολογισμούς διαδραματίζει η επιλογή της τοποθεσίας, καθώς από τόπο σε τόπο διαφέρει μία σειρά από παραμέτρους, όπως είναι τα κλιματολογικά δεδομένα, το υδροδυναμικό ύψος και το διάγραμμα ροής του ποταμού. Το πρόγραμμα RETScreen παρέχει τη δυνατότητα στο χρήστη να χρησιμοποιήσει στοιχεία από τη βάση δεδομένων ή να υπολογίσει τα χαρακτηριστικά, μετά από μελέτη της περιοχής.

Στην παρούσα εργασία επιλέχθηκαν θεωρητικά στοιχεία, μετά από μελέτη αντίστοιχων υδροηλεκτρικών έργων από τη βιβλιογραφία, βάσει των οποίων η παραγόμενη ισχύς εντάσσει την επένδυση στην κατηγορία των μικρών υδροηλεκτρικών έργων και ανέρχεται στα 2,522 MW (Παράρτημα).

6.2.2 Ανάλυση κόστους

Βασικοί παράμετροι στην εκτίμηση του κόστους κατασκευής και συντήρησης του έργου αποτελούν η επιλογή του τύπου (ροής ποταμού ή ταμιευτήρα), ο τύπος του δικτύου

(διασυνδεδεμένο ή μη) και ο αριθμός των υδροστροβίλων. Στην παρούσα εργασία ελήφθησαν δεδομένα της αγοράς μετά από μελέτη αντίστοιχων έργων από τη βιβλιογραφία. Από τη μελέτη προκύπτει ότι το κόστος των οικοδομικών εργασιών, της αγοράς και εγκατάστασης του εξοπλισμού ενός μικρού υδροηλεκτρικού έργου ροής ποταμού, σε διασυνδεδεμένο σύστημα, κυμαίνεται από 3.000 έως 5.000 €/KW, ανάλογα με τα ειδικά χαρακτηριστικά της περιοχής. Εκτός από τα παραπάνω κόστη υπάρχει το λειτουργικό και περιοδικό κόστος. Το ετήσιο λειτουργικό κόστος αντιστοιχεί στο 2,5% περίπου του κόστους κατασκευής. Στο περιοδικό κόστος περιλαμβάνεται η αντικατάσταση του υδροστροβίλου κάθε εικοσαετία.

Στην παρούσα εργασία το μοναδιαίο κόστος κατασκευής ανέρχεται στο ποσό των 4.074 €/KW.

6.2.3 Υπολογισμός εξοικονόμησης αερίων του θερμοκηπίου

Βασικό στοιχείο για τον υπολογισμό της εξοικονόμησης αερίων του θερμοκηπίου με την κατασκευή ενός υδροηλεκτρικού έργου αποτελεί ο συντελεστής εκπομπής, ο οποίος καθορίζει το αναμενόμενο δυναμικό μείωσης των ισοδύναμων εκπομπών CO_2 το οποίο θα επιτευχθεί με τη λειτουργία του υδροηλεκτρικού έργου.

Σε αυτό το υπολογιστικό φύλλο παρέχεται η δυνατότητα στο χρήστη είτε να εισάγει τα είδη των καυσίμων που χρησιμοποιούνται για την παραγωγή ηλεκτρισμού σε κάθε χώρα και το ποσοστό (%) καθενός από αυτά, ενώ το πρόγραμμα εισάγει αυτόματα τους συντελεστές εκπομπής των αερίων CO_2, CH_4 και N_2O, είτε να εισάγει το συνολικό συντελεστή εκπομπής, υπολογίζοντας τις συνολικές ετήσιες μειώσεις εκπομπών αερίων του θερμοκηπίου σε τόνους ισοδύναμου CO_2 ανά MWh.

Στο υδροηλεκτρικό έργο που εξετάζεται έγινε χρήση του συνολικού συντελεστή εκπομπής κάθε χώρας, οι βασικές τιμές των οποίων παρουσιάζονται στον Πίνακα 2 που ακολουθεί και έχουν υπολογισθεί σε μελέτη [27] που πραγματοποιήθηκε από το Εθνικό Αστεροσκοπείο Αθηνών το 2005.

Πίνακας 2: Βασικές τιμές συντελεστών εκπομπής

Χώρα	**Συντελεστής εκπομπής (t CO_2/MWh)**
Αλβανία	0,312
Βουλγαρία	0,614
Μολδαβία	0,459
Π.Γ.Δ.Μ.	0,545
Ουκρανία	0,424
Ρουμανία	0,423

6.2.4 Χρηματοοικονομική ανάλυση

Ο υπολογισμός των οικονομικών δεικτών αποτελεί βασικό κριτήριο για την ολοκληρωμένη αξιολόγηση της επένδυσης. Το πρόγραμμα RETScreen, μετά την εισαγωγή από το χρήστη ορισμένων οικονομικών παραμέτρων, παρέχει τη δυνατότητα του αυτόματου υπολογισμού του Εσωτερικού Βαθμού Απόδοσης (Internal Rate of Return – IRR), της Καθαρής Παρούσας Αξίας (Net Present Value – NPV) και του χρόνου εμφάνισης θετικής χρηματορροής (Year – to – Positive Cash Flow).

Η πρώτη παράμετρος που εισάγεται είναι η τιμή πώλησης της παραγόμενης ηλεκτρικής ενέργειας (feed – in – tariff) από ανανεώσιμη πηγή (Πίνακας 3).

Πίνακας 3: Τιμές πώλησης παραγόμενης ηλεκτρικής ενέργειας

Χώρα	**Τιμή πώλησης παραγόμενης ηλεκτρικής ενέργειας (€/kWh)**
Αλβανία (*)	0,0595
Βουλγαρία	0,0561
Μολδαβία	0,0063
Π.Γ.Δ.Μ. (*)	0,0444
Ουκρανία (*)	0,0270
Ρουμανία (*)	0,0684

(*) Χώρες χωρίς ειδικό τιμολόγιο

Εν συνεχεία, εισάγεται η τιμή πώλησης των δικαιωμάτων εκπομπών αερίων του θερμοκηπίου (CERs/ERUs), η οποία παρουσιάζει σημαντικές αυξομειώσεις, ανάλογα με την εκάστοτε σχέση προσφοράς-ζήτησης. Η τρέχουσα τιμή έχει διαμορφωθεί στα 15 €/t (www.pointcarbon.com), παρουσιάζοντας τάση σταθεροποίησης το τελευταίο χρονικό διάστημα, αλλά στην παρούσα εργασία λαμβάνεται η τιμή των 20 €/t, διότι εκτιμάται ότι μετά το τέλος της πρώτης περιόδου δέσμευσης (2008-2012) η τιμή θα κυμανθεί σε υψηλότερα επίπεδα.

Οι επόμενες παράμετροι που εισάγονται, όπως το ποσοστό αύξησης της τιμής πώλησης της ενέργειας, ο πληθωρισμός, το επιτόκιο προεξόφλησης, ο χρόνος ζωής του έργου, καθώς το επιτόκιο και το χρονικό διάστημα δανεισμού προκύπτουν κατ' εκτίμηση μετά από τη μελέτη αντίστοιχων έργων από τη βιβλιογραφία και παρουσιάζονται στον Πίνακα 4 που ακολουθεί.

Πίνακας 4: Εκτιμηθέντα χρηματοοικονομικά στοιχεία

Πληθωρισμός (%)	3
Επιτόκιο προεξόφλησης (%)	12
Διάρκεια επένδυσης (έτη)	30
Ποσοστό δανεισμού (%)	30
Επιτόκιο δανεισμού (%)	7
Χρόνος αποπληρωμής δανείου (έτη)	30
Επιδότηση (%)	30

6.3 Αποτελέσματα

Στον Πίνακα 5 παρουσιάζεται η κατάταξη των χωρών η οποία προέκυψε από τη χρήση του προγράμματος RETScreen, με μοναδικό κριτήριο την εξοικονόμηση ERUs (tCO_2/KW).

Πίνακας 5: Κατάταξη χωρών βάσει ERUs (tCO_2/KW)

Χώρες	**Εξοικονόμηση ERUs (tCO_2/KW)**
Βουλγαρία	6,38
Π.Γ.Δ.Μ.	5,67
Μολδαβία	4,77
Ρουμανία	4,40
Ουκρανία	4,41
Αλβανία	3,24

Τα κριτήρια που αποτυπώνουν την οικονομική αποδοτικότητα του έργου στην εκάστοτε χώρα είναι ο εσωτερικός βαθμός απόδοσης (Internal Rate of Return - IRR), η καθαρή παρούσα αξία (NPV) και ο χρόνος εμφάνισης θετικών χρηματορροών (Year-to-positive cash flow). Στους πίνακες 6, 7 και 8 που ακολουθούν παρουσιάζεται η κατάταξη των χωρών, η οποία προέκυψε από τη χρήση του προγράμματος RETScreen, με ή χωρίς την αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο. Στην περίπτωση που ο IRR προκύπτει αρνητικός, τότε το έργο αυτό εξαιρείται από την αξιολόγηση, διότι η οικονομική αποτελεσματικότητα μίας επενδυτικής ευκαιρίας αποτελεί το πιο βασικό κριτήριο αξιολόγησής της.

Πίνακας 6: Κατάταξη χωρών χωρίς την αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο

ΧΩΡΕΣ	IRR (%)	NPV (€)	Year-to-positive cash flow (yr)
ΡΟΥΜΑΝΙΑ	17,2	2.762.591	5,6
ΑΛΒΑΝΙΑ	13,7	882.627	6,9
ΒΟΥΛΓΑΡΙΑ	12,3	164.439	7,6
ΠΓΔΜ	7,4	(-)2.306.973	11,6
ΟΥΚΡΑΝΙΑ	(-)1,6	(-)5.982.407	>30
ΜΟΛΔΑΒΙΑ	(-)	(-)10.354.906	>30

Πίνακας 7: Κατάταξη χωρών με την αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο, με επιδότηση 30% της αρχικής επένδυσης

ΧΩΡΕΣ	IRR (%)	NPV (€)	Year-to-positive cash flow (yr)
ΡΟΥΜΑΝΙΑ	36,3	7.522.281	2,7
ΒΟΥΛΓΑΡΙΑ	30,7	5.681.632	3,2
ΑΛΒΑΝΙΑ	29,0	5.202.094	3,4
ΠΓΔΜ	22	2.936.567	4,4
ΟΥΚΡΑΝΙΑ	7,2	(-)1.218.751	10,5
ΜΟΛΔΑΒΙΑ	(-)	(-)5.452.440	>30

Πίνακας 8: Κατάταξη χωρών με την αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο χωρίς επιδότηση 30% της αρχικής επένδυσης

ΧΩΡΕΣ	IRR (%)	NPV (€)	Year-to-positive cash flow (yr)
ΡΟΥΜΑΝΙΑ	20,4	4.440.201	4,8
ΒΟΥΛΓΑΡΙΑ	17,0	2.599.552	5,6
ΑΛΒΑΝΙΑ	16,1	2.120.014	6,0
ΠΓΔΜ	11,7	(-)145.513	7,8
ΟΥΚΡΑΝΙΑ	2,1	(-)4.300.831	29,3
ΜΟΛΔΑΒΙΑ	(-)	(-)8.534.520	>30

6.4 Ανάλυση ευαισθησίας

Για την ανάλυση των επενδύσεων στον τομέα της ενέργειας, απαραίτητο στοιχείο αποτελεί η αβεβαιότητα της επένδυσης. Για το λόγο αυτό κρίνεται σκόπιμη η ανάλυση ευαισθησίας, έτσι, ώστε να μελετώνται και να ελέγχονται τα αποτελέσματα της αξιολόγησης, καθώς και η ανεύρεση εναλλακτικών λύσεων σε περίπτωση μεταβολής των παραμέτρων της επένδυσης.

Στην παρούσα εργασία, πραγματοποιείται ανάλυση ευαισθησίας στις τρεις πρώτες χώρες του πίνακα κατάταξης (Ρουμανία, Βουλγαρία και Αλβανία) μεταβάλλοντας τρεις παραμέτρους, έτσι ώστε να φανεί η επίδραση αυτών των αλλαγών στην τελική κατάταξη των χωρών και να μελετηθεί η σταθερότητα της θέσης την οποία καταλαμβάνουν (Πίνακες 9, 10, 11). Οι παράμετροι αυτοί είναι οι εξής: τιμή πώλησης της παραγόμενης ηλεκτρικής

ενέργειας (feed – in – tariff), βασική τιμή συντελεστών εκπομπής και τιμή πώλησης των δικαιωμάτων εκπομπών αερίων του θερμοκηπίου (CERs/ERUs).

Πίνακας 9: Ανάλυση ευαισθησίας με μεταβολή ±10% στην τιμή πώλησης της παραγόμενης ηλεκτρικής ενέργειας (feed – in – tariff)

	ΑΛΒΑΝΙΑ			**ΒΟΥΛΓΑΡΙΑ**			**ΡΟΥΜΑΝΙΑ**		
(€/kWh)	0,0536	0,0595	0,0655	0,0501	0,0561	0,0617	0,0616	0,0684	0,0752
	-10%	0%	10%	-10%	0%	10%	-10%	0%	10%
IRR (%)	25,1	29,0	33,0	27,0	30,7	34,4	31,9	36,3	40,7
NPV (€)	3.955.826	5.202.094	6.469.485	4.498.734	5.681.632	6.864.530	6.085.905	7.522.281	8.958.657
Year-to-positive cash flow (yr)	3,9	3,4	3,0	3,6	3,2	2,9	3,1	2,7	2,4

Πίνακας 10: Ανάλυση ευαισθησίας με μεταβολή ±10% στη βασική τιμή συντελεστών εκπομπής

	ΑΛΒΑΝΙΑ			**ΒΟΥΛΓΑΡΙΑ**			**ΡΟΥΜΑΝΙΑ**		
(t CO_2/MWh)	0,281	0,312	0,343	0,553	0,614	0,675	0,381	0,423	0,465
	-10%	0%	10%	-10%	0%	10%	-10%	0%	10%
IRR (%)	28,6	29,0	29,4	29,5	30,7	31,5	35,7	36,3	36,8
NPV (€)	5.079.148	5.202.094	5.325.039	5.439.707	5.681.632	5.923.557	7.355.710	7.522.281	7.688.852
Year-to-positive cash flow (yr)	3,4	3,4	3,3	3,3	3,2	3,1	2,8	2,7	2,7

Πίνακας 9: Ανάλυση ευαισθησίας με τιμή πώλησης των δικαιωμάτων εκπομπών αερίων του θερμοκηπίου (CERs/ERUs) 15, 20 και 25 €/t

	ΑΛΒΑΝΙΑ			**ΒΟΥΛΓΑΡΙΑ**			**ΡΟΥΜΑΝΙΑ**		
(CERs/ERUs)	15	20	25	15	20	25	15	20	25
	-10%	0%	10%	-10%	0%	10%	-10%	0%	10%
IRR (%)	28,0	29,0	30,0	28,7	30,7	32,8	34,9	36,3	37,7
NPV (€)	4.892.747	5.202.094	5.511.440	5.072.854	5.681.632	6.290.410	7.102.878	7.522.281	7.941.684
Year-to-positive cash flow (yr)	3,5	3,4	3,3	3,4	3,2	3,0	2,8	2,7	2,6

ΚΕΦΑΛΑΙΟ 7

ΚΕΦΑΛΑΙΟ 7: ΣΥΜΠΕΡΑΣΜΑΤΑ

Αντικείμενο της παρούσας εργασίας αποτελεί η αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο (CDM και JI) στο πλαίσιο ανάπτυξης ενός υδροηλεκτρικού έργου μικρής κλίμακας, με τη βοήθεια του προγράμματος RETScreen. Το πρόγραμμα RETScreen παρέχει μία μεθοδολογία που συγκρίνει με αξιόπιστο τρόπο τις συμβατικές τεχνολογίες με τις τεχνολογίες καθαρής ενέργειας και βοηθά στον καθορισμό του κατά πόσο μπορεί να πραγματοποιηθεί ένα έργο ή να απορριφθεί, έναντι άλλων εναλλακτικών. Από το πλήθος των υπολογιστικών φύλλων του προγράμματος RETScreen γίνεται αντιληπτό ότι πολλές είναι οι παράμετροι που επηρεάζουν τα αποτελέσματα της ανάλυσης και απαραίτητη προϋπόθεση για τη σωστή αξιολόγηση μίας επένδυσης αποτελεί η λεπτομερής μελέτη της εκάστοτε περιοχής επένδυσης. Βασικές παράμετροι για την εκπόνηση του έργου μέσω του συγκεκριμένου προγράμματος αποτελούν τα κλιματολογικά δεδομένα, τα χαρακτηριστικά των υδροηλεκτρικών έργων, τα αρχικά και περιοδικά κόστη της επένδυσης, το κόστος της παραγόμενης ενέργειας, τα χρηματοοικονομικά μεγέθη, το ύψος των κρατικών επιδοτήσεων, καθώς και οι παραδοχές και το επίπεδο αβεβαιότητας του χρήστη του προγράμματος.

Στην παρούσα μελέτη, αρχικά, επιλέχθηκαν ή υπολογίσθηκαν τα τεχνικά χαρακτηριστικά του έργου, μετά από μελέτη αντίστοιχων έργων από τη βιβλιογραφία. Αυτά, θεωρήθηκε ότι παραμένουν σταθερά για όλες τις χώρες, παρόλο που από τόπο σε τόπο διαφέρουν τα ειδικά χαρακτηριστικά. Έτσι, η σύγκριση και η κατάταξη των χωρών στηρίχθηκε σε παραμέτρους όπως το αναμενόμενο δυναμικό μείωσης των ισοδύναμων εκπομπών CO_2, η τιμή πώλησης του ηλεκτρισμού, ο συντελεστής εκπομπής.

Με τη λειτουργία του υδροηλεκτρικού έργου προέκυψε η παρακάτω κατάταξη των χωρών υποδοχής, με βάση το αναμενόμενο δυναμικό μείωσης των ισοδύναμων εκπομπών CO_2:

1. Βουλγαρία
2. Π.Γ.Δ.Μ.
3. Μολδαβία
4. Ρουμανία

5. Ουκρανία
6. Αλβανία

Επειδή η οικονομική αποτελεσματικότητα μίας επενδυτικής ευκαιρίας αποτελεί το πιο βασικό κριτήριο αξιολόγησής της, παραγματοποιήθηκε σύγκριση των εξεταζόμενων χωρών, με ή χωρίς την αξιοποίηση των ευέλικτων μηχανισμών του Πρωτοκόλλου του Κιότο με βάση τον εσωτερικό βαθμό απόδοσης (Internal Rate of Return - IRR) και την καθαρή παρούσα αξία (NPV).

Από τη σύγκριση προέκυψε ότι σε όλες τις χώρες υποδοχής, οι δείκτες βιωσιμότητας της επένδυσης βελτιώνονται με την αξιοποίηση των ευέλικτων μηχανισμών. Παρατηρήθηκε επίσης, ότι πιο συμφέρουσα κρίνεται η επένδυση για τις χώρες με υψηλότερη τιμολόγηση της ηλεκτρικής ενέργειας και όσο μεγαλύτερη είναι η τιμή αυτή τόσο μεγαλύτερη είναι η απόδοση της επένδυσης με τη Ρουμανία, τη Βουλγαρία και την Αλβανία να κατέχουν τις τρεις πρώτες θέσεις στην κατάταξη. Σημειώνεται, ότι για τη Μολδαβία όπου δεν υφίσταται ειδικό τιμολόγιο, η επένδυση κρίνεται μη συμφέρουσα με το δείκτη IRR να είναι αρνητικός.

Εν συνεχεία, πραγματοποιήθηκε ανάλυση ευαισθησίας, με μεταβλητές τις εξής παραμέτρους: τιμή πώλησης της παραγόμενης ηλεκτρικής ενέργειας (feed – in – tariff), βασική τιμή συντελεστών εκπομπής και τιμή πώλησης των δικαιωμάτων εκπομπών αερίων του θερμοκηπίου (CERs/ERUs). Από τη μελέτη των αποτελεσμάτων προέκυψε ότι η επίδραση αυτών των αλλαγών στην τελική κατάταξη των χωρών δε μεταβάλλει τη θέση την οποία αυτές καταλαμβάνουν.

Τέλος, σημειώνεται, ότι λόγω του πλήθους των παραμέτρων του προγράμματος RETScreen, υπάρχει η δυνατότητα, μεταβάλλοντας αρκετές φορές τα δεδομένα, να επιτευχθεί η βελτιστοποίηση του εξεταζόμενου έργου.

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ΠΑΡΑΡΤΗΜΑ

RETScreen® Energy Model - Small Hydro Project

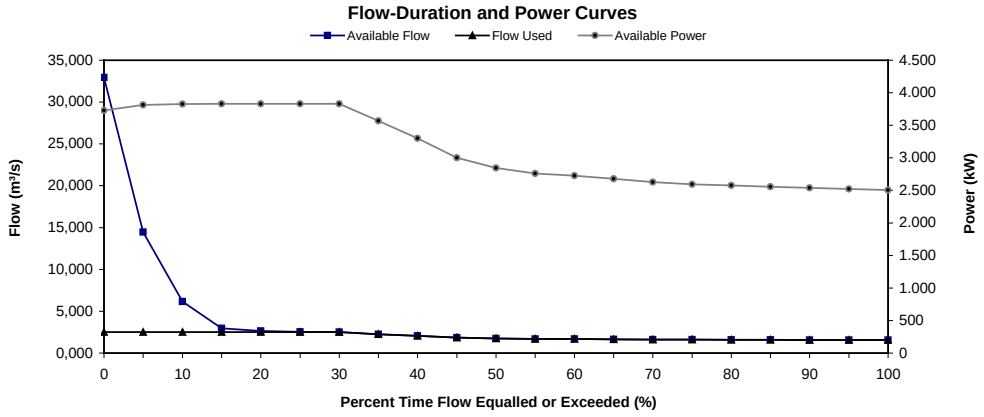
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		**Small Hydro**	*See Online Manual*
Project location		**ALBANIA**	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	*Complete Hydrology & Load sheet*
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	*Complete Equipment Data sheet*
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



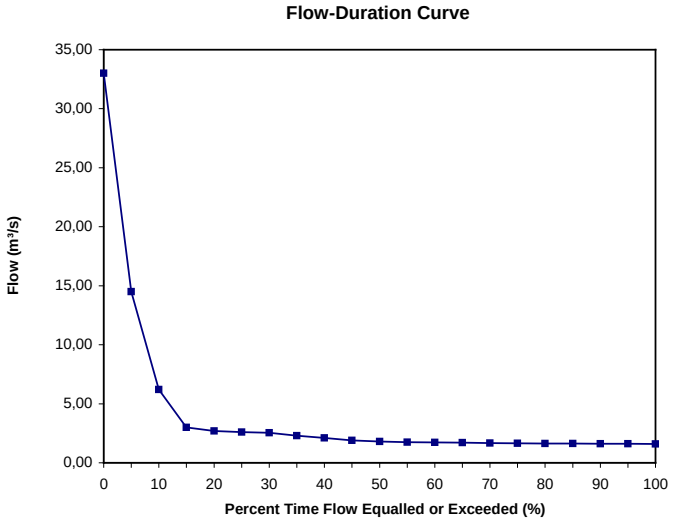
Complete Cost Analysis sheet

RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

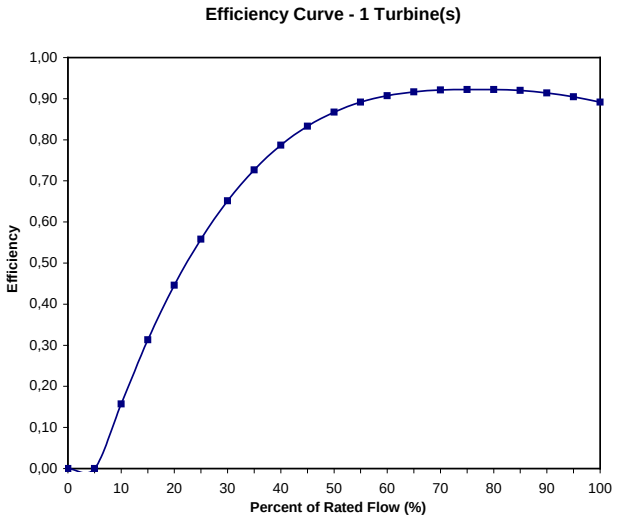
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



Return to Energy Model sheet

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)	Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study	€ 318.400	1,00	**€ 318.400**	3,1%
Development	€ 342.400	1,00	€ 342.400	3,3%
Land rights			€ -	0,0%
Development Sub-total:			**€ 342.400**	3,3%
Engineering	€ 555.200	1,00	**€ 555.200**	5,4%
Energy Equipment	€ 1.864.000	1,00	**€ 1.864.000**	18,1%
Balance of Plant				
Access road	€ 342.400	1,00	€ 342.400	3,3%
Transmission line	€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer	€ 124.800	1,00	€ 124.800	1,2%
Penstock	€ -	1,00	€ -	0,0%
Canal	€ -	1,00	€ -	0,0%
Tunnel	€ -	1,00	€ -	0,0%
Civil works (other)	€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:	€ 6.136.000		**€ 6.136.000**	59,7%
Miscellaneous	€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP (Cost)	€ -		€ -	0,0%
GHG validation and registration (Cost)	€ -		€ -	0,0%
Miscellaneous Sub-total:			**€ 1.057.600**	10,3%
Initial Costs - Total (Formula Method)	€ 10.273.600		**€ 10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-
Contingencies	%	10%	€ 222.797	€ 22.280		-	-
Annual Costs - Total				**€ 245.076**	100,0%		

ETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

se GHG analysis sheet?	Yes	Type of analysis:	User-defined
otential CDM project?	Yes	Use simplified baseline methods?	No

ackground Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	ALBANIA	Grid type	Central-grid

ase Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,312	8,0%	0,339

Does baseline change during project life? No

oposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

HG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,339	0,000	24.125	8.182	0,0%	**8.182**

Complete Financial Summary sheet

ersion 3.2 UNEP/DTIE and NRCan/CETC - Varennes

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		ALBANIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	8.182
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	171.814
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	245.448

Financial Parameters

Avoided cost of energy	€/kWh	0,0595	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.560.274
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	163.632
				Annual Savings - Total	**€**	**1.723.906**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

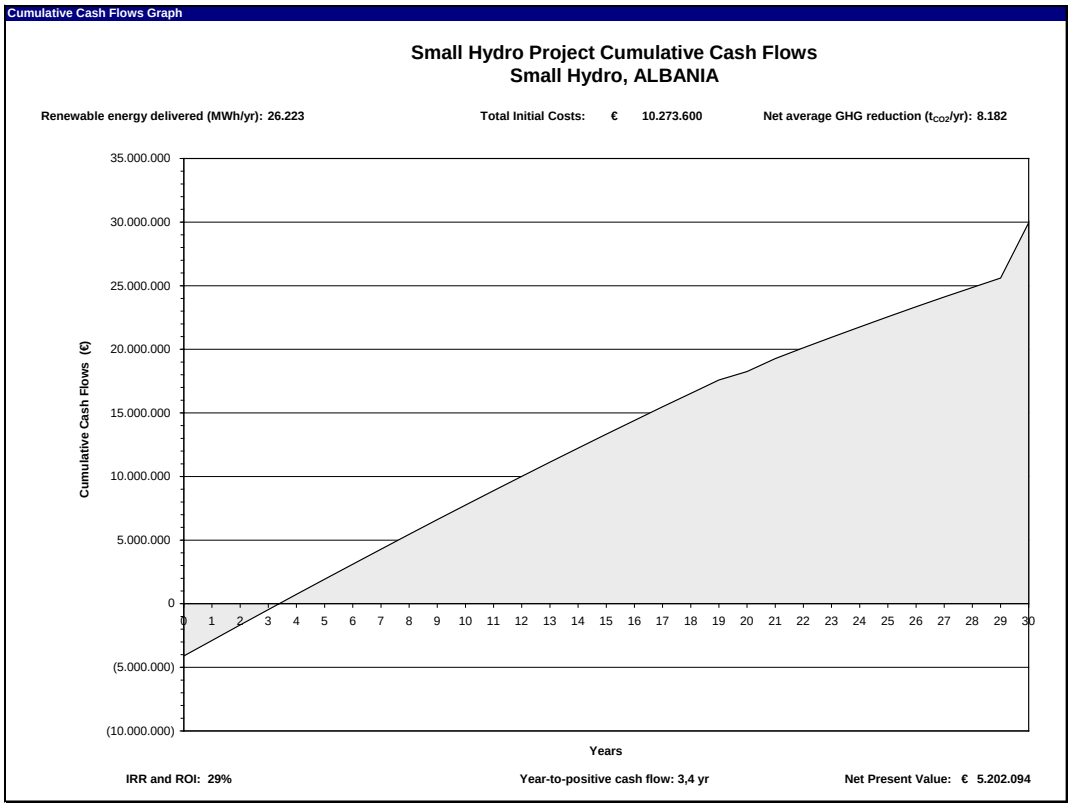
			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	29,0%			
After-tax IRR and ROI	%	29,0%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	4,9			
Year-to-positive cash flow	yr	3,4	Project equity	€	7.191.520
Net Present Value - NPV	€	5.202.094	Project debt	€	3.082.080
Annual Life Cycle Savings	€	645.807	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,72	Debt service coverage	-	5,92

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	1.223.104	1.223.104	(2.886.336)
2	1.215.531	1.215.531	(1.670.805)
3	1.207.731	1.207.731	(463.075)
4	1.199.697	1.199.697	736.622
5	1.191.422	1.191.422	1.928.044
6	1.182.898	1.182.898	3.110.942
7	1.174.119	1.174.119	4.285.061
8	1.165.077	1.165.077	5.450.138
9	1.155.763	1.155.763	6.605.902
10	1.146.170	1.146.170	7.752.072
11	1.136.289	1.136.289	8.888.361
12	1.126.112	1.126.112	10.014.473
13	1.115.629	1.115.629	11.130.103
14	1.104.832	1.104.832	12.234.935
15	1.093.711	1.093.711	13.328.647
16	1.082.257	1.082.257	14.410.903
17	1.070.458	1.070.458	15.481.362
18	1.058.306	1.058.306	16.539.668
19	1.045.789	1.045.789	17.585.458
20	671.675	671.675	18.257.133
21	1.019.618	1.019.618	19.276.751
22	842.309	842.309	20.119.059
23	828.221	828.221	20.947.280
24	813.711	813.711	21.760.991
25	798.765	798.765	22.559.756
26	783.371	783.371	23.343.126
27	767.515	767.515	24.110.641
28	751.183	751.183	24.861.825
29	734.362	734.362	25.596.186
30	4.357.929	4.357.929	29.954.116

Version 3.2

NRCan/CETC - Varennes



RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		ALBANIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	8.182
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	171.814
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	245.448

Financial Parameters

Avoided cost of energy	€/kWh	0,0595	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.560.274
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	163.632
				Annual Savings - Total	**€**	**1.723.906**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	16,1%			
After-tax IRR and ROI	%	16,1%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	6,9			
Year-to-positive cash flow	yr	6,0	Project equity	€	7.191.520
Net Present Value - NPV	€	2.120.014	Project debt	€	3.082.080
Annual Life Cycle Savings	€	263.186	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,29	Debt service coverage	-	5,92

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	1.223.104	1.223.104	(5.968.416)
2	1.215.531	1.215.531	(4.752.885)
3	1.207.731	1.207.731	(3.545.155)
4	1.199.697	1.199.697	(2.345.458)
5	1.191.422	1.191.422	(1.154.036)
6	1.182.898	1.182.898	28.862
7	1.174.119	1.174.119	1.202.981
8	1.165.077	1.165.077	2.368.058
9	1.155.763	1.155.763	3.523.822
10	1.146.170	1.146.170	4.669.992
11	1.136.289	1.136.289	5.806.281
12	1.126.112	1.126.112	6.932.393
13	1.115.629	1.115.629	8.048.023
14	1.104.832	1.104.832	9.152.855
15	1.093.711	1.093.711	10.246.567
16	1.082.257	1.082.257	11.328.823
17	1.070.458	1.070.458	12.399.282
18	1.058.306	1.058.306	13.457.588
19	1.045.789	1.045.789	14.503.378
20	671.675	671.675	15.175.053
21	1.019.618	1.019.618	16.194.671
22	842.309	842.309	17.036.979
23	828.221	828.221	17.865.200
24	813.711	813.711	18.678.911
25	798.765	798.765	19.477.676
26	783.371	783.371	20.261.046
27	767.515	767.515	21.028.561
28	751.183	751.183	21.779.745
29	734.362	734.362	22.514.106
30	4.357.929	4.357.929	26.872.036

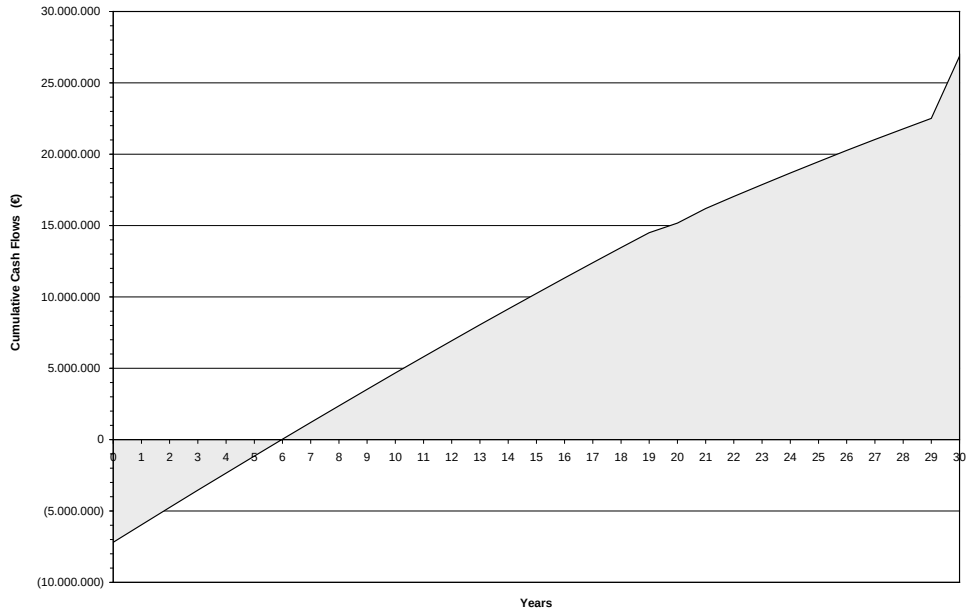
Version 3.2

NRCan/CETC - Varennes

Cumulative Cash Flows Graph

Small Hydro Project Cumulative Cash Flows
Small Hydro, ALBANIA

Renewable energy delivered (MWh/yr): 26.223 **Total Initial Costs: € 10.273.600** **Net average GHG reduction (t_{CO2}/yr): 8.182**



IRR and ROI: 16,1% **Year-to-positive cash flow: 6 yr** **Net Present Value: € 2.120.014**

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No *Complete Financial Summary sheet*

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		ALBANIA
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0595	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.560.274
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**1.560.274**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

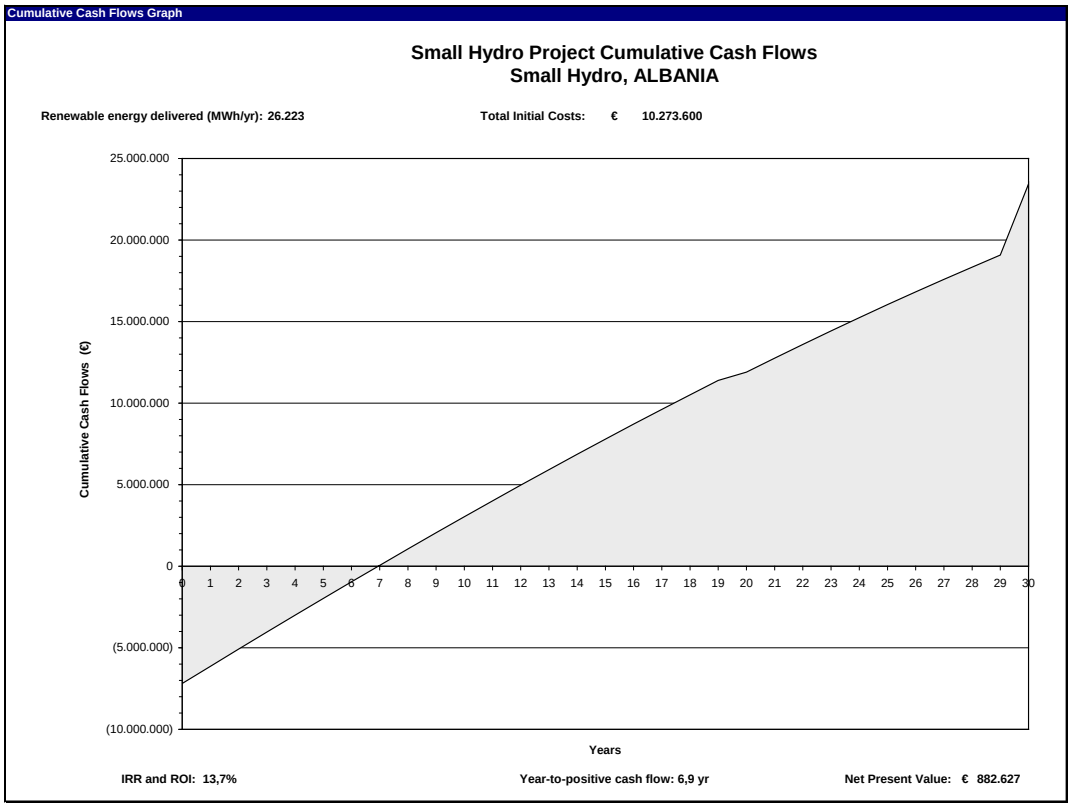
			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	13,7%			
After-tax IRR and ROI	%	13,7%			
Simple Payback	yr	7,8			
Year-to-positive cash flow	yr	6,9	Project equity	€	7.191.520
Net Present Value - NPV	€	882.627	Project debt	€	3.082.080
Annual Life Cycle Savings	€	109.573	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,12	Debt service coverage	-	5,27

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	1.059.472	1.059.472	(6.132.048)
2	1.051.899	1.051.899	(5.080.150)
3	1.044.099	1.044.099	(4.036.051)
4	1.036.065	1.036.065	(2.999.986)
5	1.027.790	1.027.790	(1.972.197)
6	1.019.266	1.019.266	(952.930)
7	1.010.487	1.010.487	57.557
8	1.001.445	1.001.445	1.059.002
9	992.131	992.131	2.051.133
10	982.538	982.538	3.033.671
11	972.657	972.657	4.006.328
12	962.480	962.480	4.968.808
13	951.997	951.997	5.920.806
14	941.200	941.200	6.862.006
15	930.079	930.079	7.792.085
16	918.625	918.625	8.710.710
17	906.826	906.826	9.617.536
18	894.674	894.674	10.512.210
19	882.157	882.157	11.394.368
20	508.043	508.043	11.902.411
21	855.986	855.986	12.758.397
22	842.309	842.309	13.600.705
23	828.221	828.221	14.428.926
24	813.711	813.711	15.242.637
25	798.765	798.765	16.041.402
26	783.371	783.371	16.824.773
27	767.515	767.515	17.592.287
28	751.183	751.183	18.343.471
29	734.362	734.362	19.077.833
30	4.357.929	4.357.929	23.435.762

Version 3.2

NRCan/CETC - Varennes



RETScreen® Energy Model - Small Hydro Project

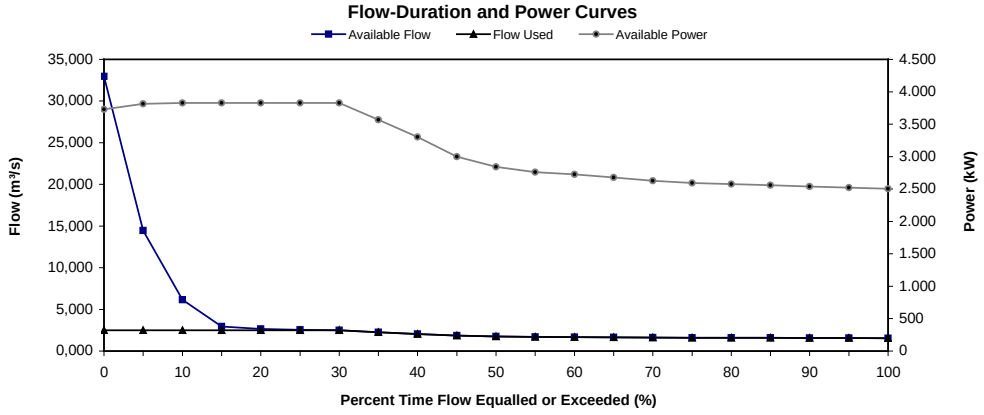
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		**Small Hydro**	*See Online Manual*
Project location		**BULGARIA**	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	*Complete Hydrology & Load sheet*
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	*Complete Equipment Data sheet*
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



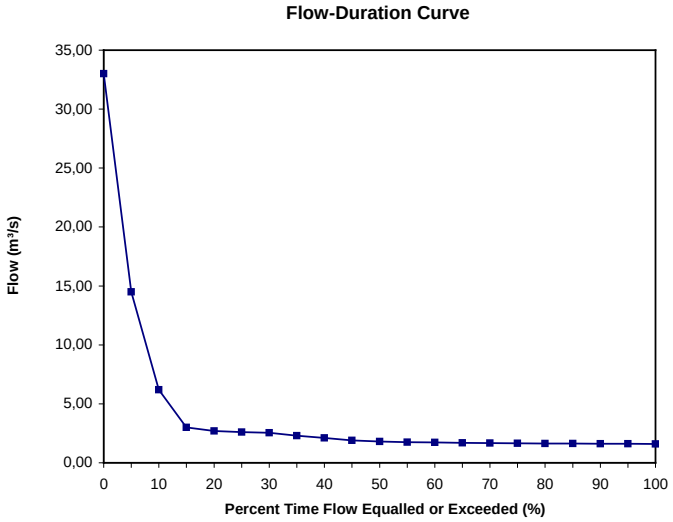
Complete Cost Analysis sheet

RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

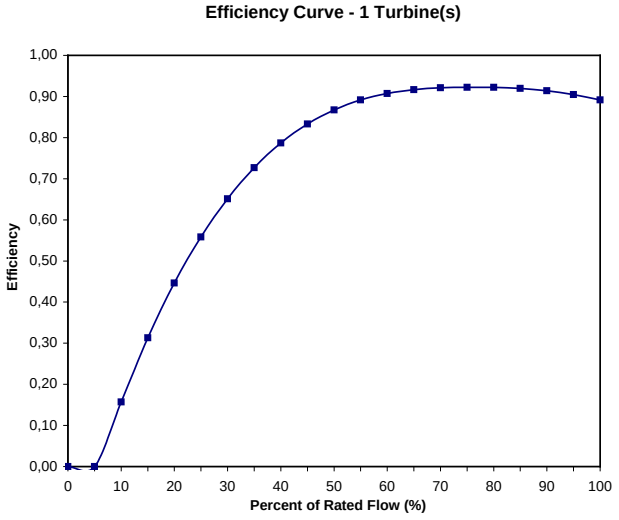
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



Return to Energy Model sheet

RETScreen® Cost Analysis - Small Hydro Project

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)		Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study		€ 318.400	1,00	€ **318.400**	3,1%
Development		€ 342.400	1,00	€ 342.400	3,3%
Land rights				€ -	0,0%
Development Sub-total:				€ **342.400**	3,3%
Engineering		€ 555.200	1,00	€ **555.200**	5,4%
Energy Equipment		€ 1.864.000	1,00	€ **1.864.000**	18,1%
Balance of Plant					
Access road		€ 342.400	1,00	€ 342.400	3,3%
Transmission line		€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer		€ 124.800	1,00	€ 124.800	1,2%
Penstock		€ -	1,00	€ -	0,0%
Canal		€ -	1,00	€ -	0,0%
Tunnel		€ -	1,00	€ -	0,0%
Civil works (other)		€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:		€ 6.136.000		€ **6.136.000**	59,7%
Miscellaneous		€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP	Cost	€ -		€ -	0,0%
GHG validation and registration	Cost	€ -		€ -	0,0%
Miscellaneous Sub-total:				€ **1.057.600**	10,3%
Initial Costs - Total (Formula Method)		€ 10.273.600		€ **10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet?	Yes	Type of analysis:	User-defined
Potential CDM project?	Yes	Use simplified baseline methods?	No

Background Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	BULGARIA	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,614	8,0%	0,667

Does baseline change during project life? No

Proposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,667	0,000	24.125	16.101	0,0%	**16.101**

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		BULGARIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	16.101
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	338.121
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	483.029

Financial Parameters

Avoided cost of energy	€/kWh	0,0561	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.471.115
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	322.020
				Annual Savings - Total	**€**	**1.793.135**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	30,7%			
After-tax IRR and ROI	%	30,7%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	4,6			
Year-to-positive cash flow	yr	3,2	Project equity	€	7.191.520
Net Present Value - NPV	€	5.681.632	Project debt	€	3.082.080
Annual Life Cycle Savings	€	705.339	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,79	Debt service coverage	-	6,20

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	1.292.333	1.292.333	(2.817.107)
2	1.284.760	1.284.760	(1.532.348)
3	1.276.960	1.276.960	(255.388)
4	1.268.926	1.268.926	1.013.538
5	1.260.651	1.260.651	2.274.189
6	1.252.127	1.252.127	3.526.316
7	1.243.348	1.243.348	4.769.664
8	1.234.306	1.234.306	6.003.970
9	1.224.992	1.224.992	7.228.962
10	1.215.399	1.215.399	8.444.362
11	1.205.518	1.205.518	9.649.880
12	1.195.341	1.195.341	10.845.221
13	1.184.858	1.184.858	12.030.079
14	1.174.061	1.174.061	13.204.141
15	1.162.940	1.162.940	14.367.081
16	1.151.486	1.151.486	15.518.567
17	1.139.687	1.139.687	16.658.254
18	1.127.535	1.127.535	17.785.789
19	1.115.018	1.115.018	18.900.808
20	740.904	740.904	19.641.712
21	1.088.847	1.088.847	20.730.559
22	753.150	753.150	21.483.709
23	739.062	739.062	22.222.771
24	724.552	724.552	22.947.323
25	709.606	709.606	23.656.930
26	694.212	694.212	24.351.142
27	678.356	678.356	25.029.498
28	662.025	662.025	25.691.523
29	645.203	645.203	26.336.727
30	4.268.771	4.268.771	30.605.497

Version 3.2

NRCan/CETC - Varennes

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		BULGARIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	16.101
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	338.121
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	483.029

Financial Parameters

Avoided cost of energy	€/kWh	0,0561	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.471.115
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	322.020
				Annual Savings - Total	**€**	**1.793.135**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	17,0%			
After-tax IRR and ROI	%	17,0%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	6,6			
Year-to-positive cash flow	yr	5,6	Project equity	€	7.191.520
Net Present Value - NPV	€	2.599.552	Project debt	€	3.082.080
Annual Life Cycle Savings	€	322.718	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,36	Debt service coverage	-	6,20

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	1.292.333	1.292.333	(5.899.187)
2	1.284.760	1.284.760	(4.614.428)
3	1.276.960	1.276.960	(3.337.468)
4	1.268.926	1.268.926	(2.068.542)
5	1.260.651	1.260.651	(807.891)
6	1.252.127	1.252.127	444.236
7	1.243.348	1.243.348	1.687.584
8	1.234.306	1.234.306	2.921.890
9	1.224.992	1.224.992	4.146.882
10	1.215.399	1.215.399	5.362.282
11	1.205.518	1.205.518	6.567.800
12	1.195.341	1.195.341	7.763.141
13	1.184.858	1.184.858	8.947.999
14	1.174.061	1.174.061	10.122.061
15	1.162.940	1.162.940	11.285.001
16	1.151.486	1.151.486	12.436.487
17	1.139.687	1.139.687	13.576.174
18	1.127.535	1.127.535	14.703.709
19	1.115.018	1.115.018	15.818.728
20	740.904	740.904	16.559.632
21	1.088.847	1.088.847	17.648.479
22	753.150	753.150	18.401.629
23	739.062	739.062	19.140.691
24	724.552	724.552	19.865.243
25	709.606	709.606	20.574.850
26	694.212	694.212	21.269.062
27	678.356	678.356	21.947.418
28	662.025	662.025	22.609.443
29	645.203	645.203	23.254.647
30	4.268.771	4.268.771	27.523.417

Version 3.2

NRCan/CETC - Varennes

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No

Complete Financial Summary sheet

Version 3.2

UNEP/DTIE and NRCan/CETC - Varennes

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		BULGARIA
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0561	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.471.115
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**1.471.115**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	12,3%			
After-tax IRR and ROI	%	12,3%			
Simple Payback	yr	8,4			
Year-to-positive cash flow	yr	7,6	Project equity	€	7.191.520
Net Present Value - NPV	€	164.439	Project debt	€	3.082.080
Annual Life Cycle Savings	€	20.414	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,02	Debt service coverage	-	4,91

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	970.313	970.313	(6.221.207)
2	962.740	962.740	(5.258.467)
3	954.940	954.940	(4.303.526)
4	946.906	946.906	(3.356.620)
5	938.631	938.631	(2.417.989)
6	930.108	930.108	(1.487.882)
7	921.329	921.329	(566.553)
8	912.286	912.286	345.734
9	902.973	902.973	1.248.706
10	893.380	893.380	2.142.086
11	883.499	883.499	3.025.585
12	873.321	873.321	3.898.906
13	862.839	862.839	4.761.745
14	852.042	852.042	5.613.787
15	840.921	840.921	6.454.708
16	829.466	829.466	7.284.174
17	817.668	817.668	8.101.842
18	805.516	805.516	8.907.357
19	792.999	792.999	9.700.356
20	418.884	418.884	10.119.241
21	766.828	766.828	10.886.068
22	753.150	753.150	11.639.218
23	739.062	739.062	12.378.281
24	724.552	724.552	13.102.833
25	709.606	709.606	13.812.439
26	694.212	694.212	14.506.651
27	678.356	678.356	15.185.008
28	662.025	662.025	15.847.032
29	645.203	645.203	16.492.236
30	4.268.771	4.268.771	20.761.007

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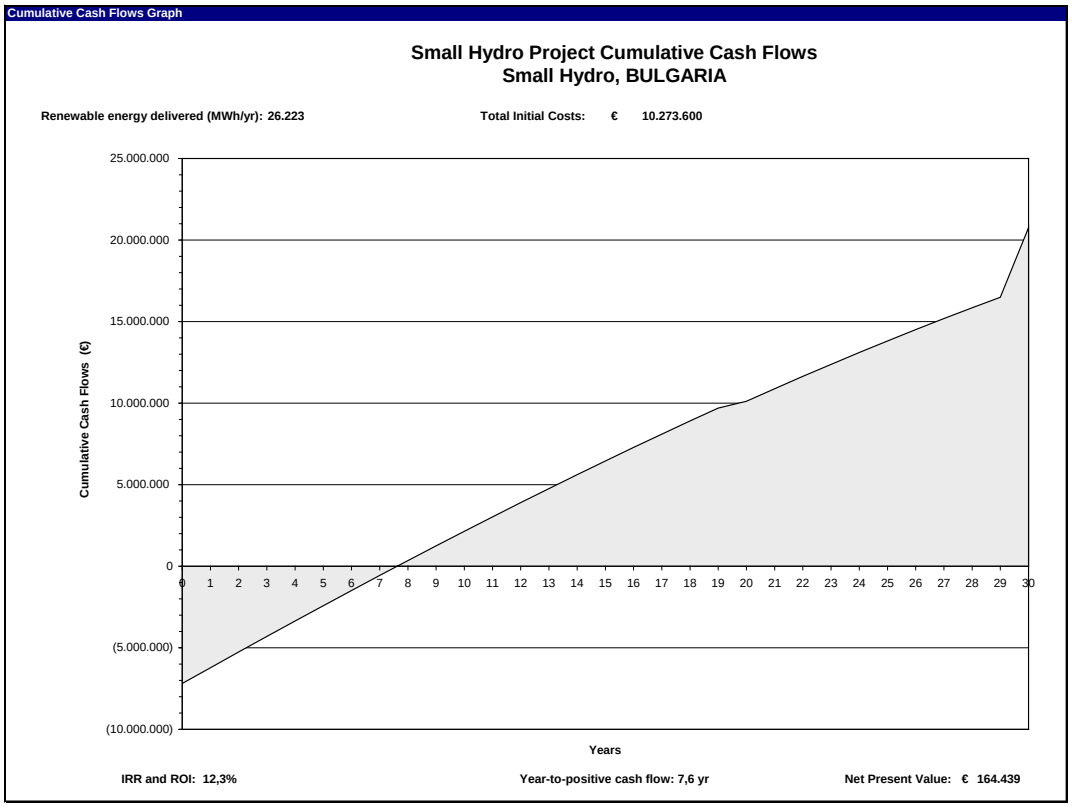

Version 3.2

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RETScreen® Energy Model - Small Hydro Project

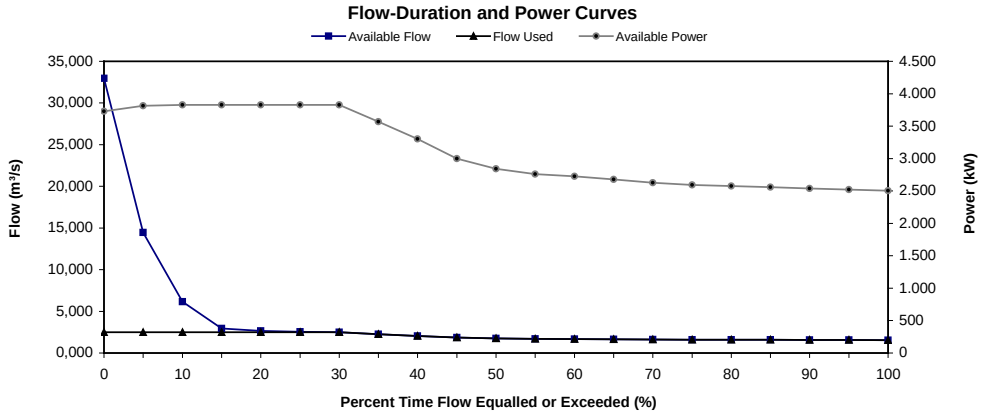
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		Small Hydro	*See Online Manual*
Project location		MOLDOVA	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	*Complete Hydrology & Load sheet*
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	*Complete Equipment Data sheet*
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



Complete Cost Analysis sheet

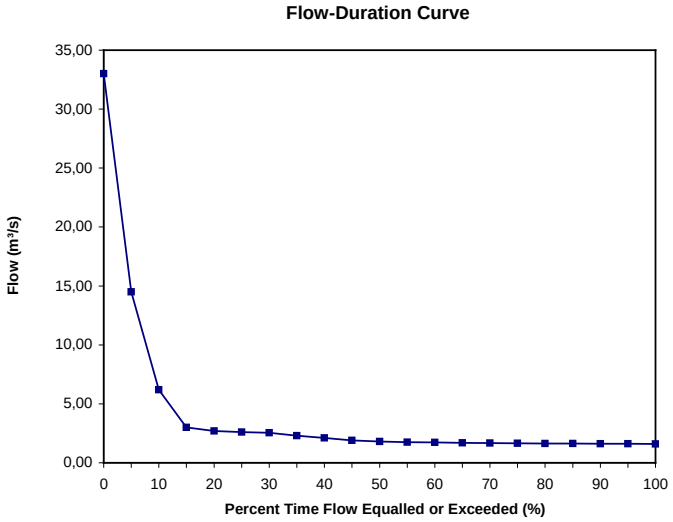
Version 3.2 NRCan/CETC - Varennes

RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

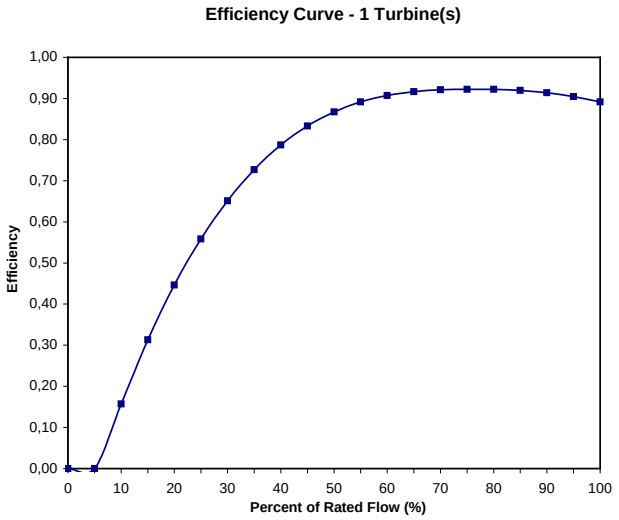
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



Return to Energy Model sheet

RETScreen® Cost Analysis - Small Hydro Project

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)		Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study		€ 318.400	1,00	**€ 318.400**	3,1%
Development		€ 342.400	1,00	€ 342.400	3,3%
Land rights				€ -	0,0%
Development Sub-total:				**€ 342.400**	3,3%
Engineering		€ 555.200	1,00	**€ 555.200**	5,4%
Energy Equipment		€ 1.864.000	1,00	**€ 1.864.000**	18,1%
Balance of Plant					
Access road		€ 342.400	1,00	€ 342.400	3,3%
Transmission line		€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer		€ 124.800	1,00	€ 124.800	1,2%
Penstock		€ -	1,00	€ -	0,0%
Canal		€ -	1,00	€ -	0,0%
Tunnel		€ -	1,00	€ -	0,0%
Civil works (other)		€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:		€ 6.136.000		**€ 6.136.000**	59,7%
Miscellaneous		€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP	Cost	€ -		€ -	0,0%
GHG validation and registration	Cost	€ -		€ -	0,0%
Miscellaneous Sub-total:				**€ 1.057.600**	10,3%
Initial Costs - Total (Formula Method)		€ 10.273.600		**€ 10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet?	Yes	Type of analysis:	User-defined
Potential CDM project?	Yes	Use simplified baseline methods?	No

Background Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	MOLDOVA	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,459	8,0%	0,499

Does baseline change during project life? No

Proposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,499	0,000	24.125	12.036	0,0%	**12.036**

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		MOLDOVA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	12.036
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	252.764
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	361.092

Financial Parameters

Avoided cost of energy	€/kWh	0,0063	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	165.205
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	240.728
				Annual Savings - Total	**€**	**405.933**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	44,7			
Year-to-positive cash flow	yr	more than 30	Project equity	€	7.191.520
Net Present Value - NPV	€	(5.452.440)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(676.886)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,24	Debt service coverage	-	(1,66)

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	(94.869)	(94.869)	(4.204.309)
2	(102.442)	(102.442)	(4.306.751)
3	(110.242)	(110.242)	(4.416.992)
4	(118.276)	(118.276)	(4.535.268)
5	(126.551)	(126.551)	(4.661.819)
6	(135.074)	(135.074)	(4.796.893)
7	(143.853)	(143.853)	(4.940.747)
8	(152.896)	(152.896)	(5.093.642)
9	(162.209)	(162.209)	(5.255.851)
10	(171.802)	(171.802)	(5.427.654)
11	(181.683)	(181.683)	(5.609.337)
12	(191.860)	(191.860)	(5.801.198)
13	(202.343)	(202.343)	(6.003.541)
14	(213.140)	(213.140)	(6.216.681)
15	(224.261)	(224.261)	(6.440.942)
16	(235.716)	(235.716)	(6.676.658)
17	(247.514)	(247.514)	(6.924.172)
18	(259.666)	(259.666)	(7.183.838)
19	(272.183)	(272.183)	(7.456.021)
20	(646.298)	(646.298)	(8.102.319)
21	(298.354)	(298.354)	(8.400.673)
22	(552.760)	(552.760)	(8.953.433)
23	(566.848)	(566.848)	(9.520.281)
24	(581.358)	(581.358)	(10.101.639)
25	(596.304)	(596.304)	(10.697.942)
26	(611.698)	(611.698)	(11.309.640)
27	(627.554)	(627.554)	(11.937.193)
28	(643.885)	(643.885)	(12.581.079)
29	(660.707)	(660.707)	(13.241.785)
30	2.962.861	2.962.861	(10.278.924)

Version 3.2

NRCan/CETC - Varennes

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		MOLDOVA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	12.036
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	252.764
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	361.092

Financial Parameters

Avoided cost of energy	€/kWh	0,0063	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	165.205
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	240.728
				Annual Savings - Total	**€**	**405.933**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	63,9			
Year-to-positive cash flow	yr	more than 30	Project equity	€	7.191.520
Net Present Value - NPV	€	(8.534.520)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(1.059.507)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	(0,19)	Debt service coverage	-	(1,66)

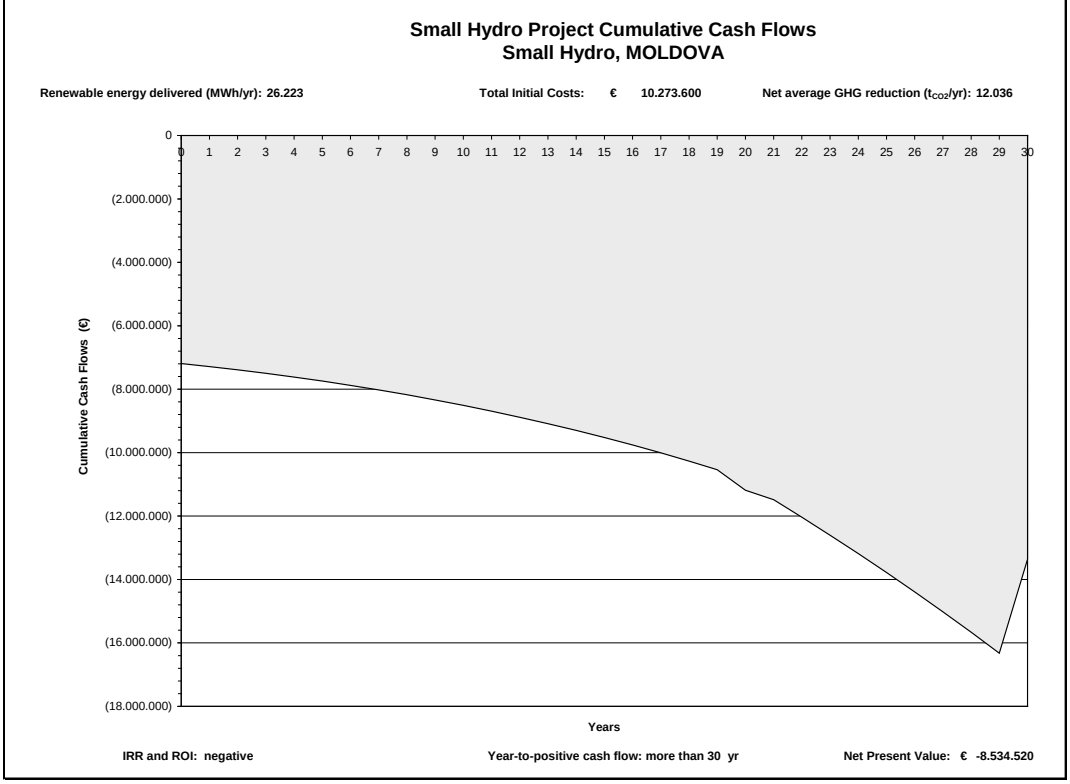
Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	(94.869)	(94.869)	(7.286.389)
2	(102.442)	(102.442)	(7.388.831)
3	(110.242)	(110.242)	(7.499.072)
4	(118.276)	(118.276)	(7.617.348)
5	(126.551)	(126.551)	(7.743.899)
6	(135.074)	(135.074)	(7.878.973)
7	(143.853)	(143.853)	(8.022.827)
8	(152.896)	(152.896)	(8.175.722)
9	(162.209)	(162.209)	(8.337.931)
10	(171.802)	(171.802)	(8.509.734)
11	(181.683)	(181.683)	(8.691.417)
12	(191.860)	(191.860)	(8.883.278)
13	(202.343)	(202.343)	(9.085.621)
14	(213.140)	(213.140)	(9.298.761)
15	(224.261)	(224.261)	(9.523.022)
16	(235.716)	(235.716)	(9.758.738)
17	(247.514)	(247.514)	(10.006.252)
18	(259.666)	(259.666)	(10.265.918)
19	(272.183)	(272.183)	(10.538.101)
20	(646.298)	(646.298)	(11.184.399)
21	(298.354)	(298.354)	(11.482.753)
22	(552.760)	(552.760)	(12.035.513)
23	(566.848)	(566.848)	(12.602.361)
24	(581.358)	(581.358)	(13.183.719)
25	(596.304)	(596.304)	(13.780.022)
26	(611.698)	(611.698)	(14.391.720)
27	(627.554)	(627.554)	(15.019.273)
28	(643.885)	(643.885)	(15.663.159)
29	(660.707)	(660.707)	(16.323.865)
30	2.962.861	2.962.861	(13.361.004)

Version 3.2

NRCan/CETC - Varennes

Cumulative Cash Flows Graph



RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		MOLDOVA
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0063	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	165.205
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**165.205**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

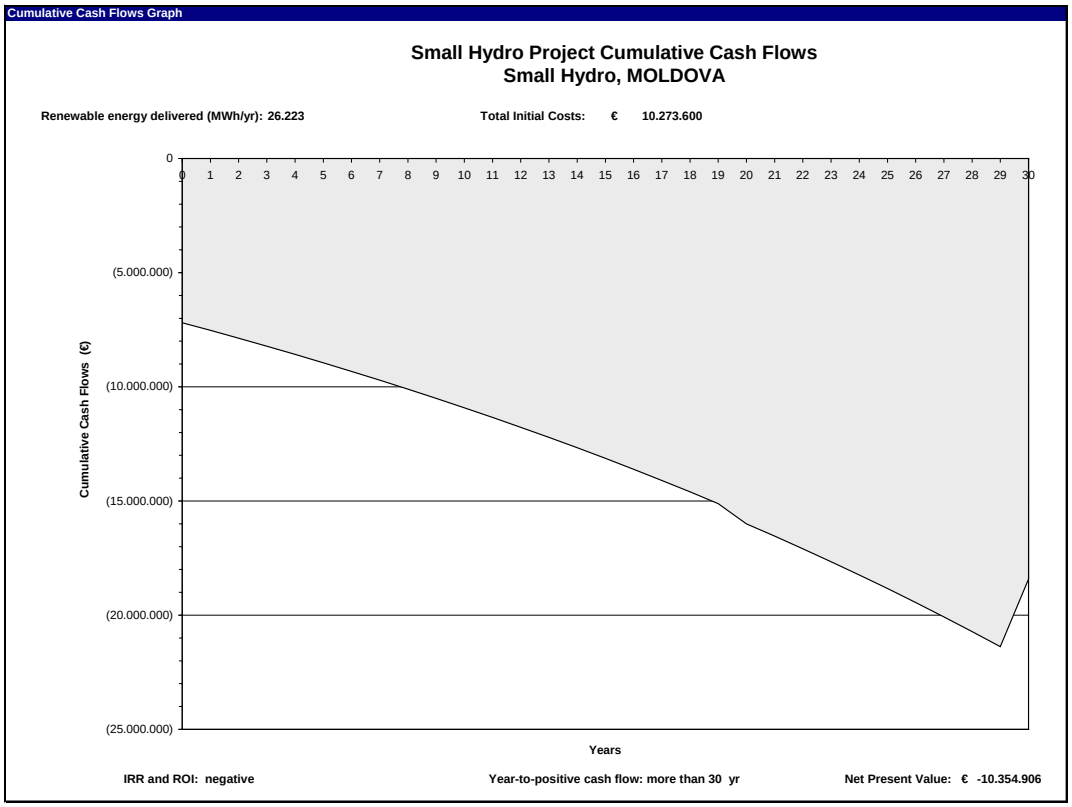
			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative			
Simple Payback	yr	(128,6)			
Year-to-positive cash flow	yr	more than 30	Project equity	€	7.191.520
Net Present Value - NPV	€	(10.354.906)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(1.285.496)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	(0,44)	Debt service coverage	-	(2,57)

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	(335.597)	(335.597)	(7.527.117)
2	(343.170)	(343.170)	(7.870.287)
3	(350.970)	(350.970)	(8.221.256)
4	(359.004)	(359.004)	(8.580.260)
5	(367.279)	(367.279)	(8.947.539)
6	(375.802)	(375.802)	(9.323.341)
7	(384.581)	(384.581)	(9.707.922)
8	(393.624)	(393.624)	(10.101.546)
9	(402.937)	(402.937)	(10.504.483)
10	(412.530)	(412.530)	(10.917.014)
11	(422.411)	(422.411)	(11.339.425)
12	(432.588)	(432.588)	(11.772.013)
13	(443.071)	(443.071)	(12.215.084)
14	(453.868)	(453.868)	(12.668.953)
15	(464.989)	(464.989)	(13.133.942)
16	(476.444)	(476.444)	(13.610.385)
17	(488.242)	(488.242)	(14.098.628)
18	(500.394)	(500.394)	(14.599.022)
19	(512.911)	(512.911)	(15.111.933)
20	(887.026)	(887.026)	(15.998.958)
21	(539.082)	(539.082)	(16.538.041)
22	(552.760)	(552.760)	(17.090.801)
23	(566.848)	(566.848)	(17.657.648)
24	(581.358)	(581.358)	(18.239.006)
25	(596.304)	(596.304)	(18.835.310)
26	(611.698)	(611.698)	(19.447.007)
27	(627.554)	(627.554)	(20.074.561)
28	(643.885)	(643.885)	(20.718.446)
29	(660.707)	(660.707)	(21.379.153)
30	2.962.861	2.962.861	(18.416.292)

Version 3.2

NRCan/CETC - Varennes



RETScreen® Energy Model - Small Hydro Project

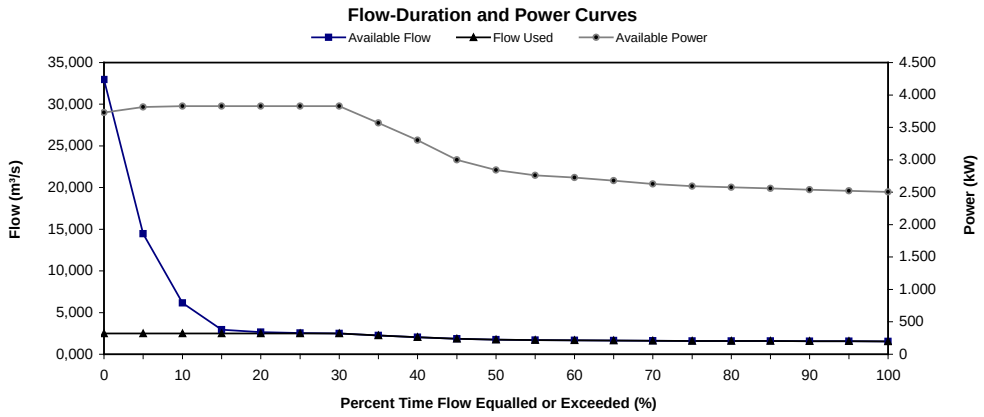
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		Small Hydro	*See Online Manual*
Project location		FYROM	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	*Complete Hydrology & Load sheet*
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	*Complete Equipment Data sheet*
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



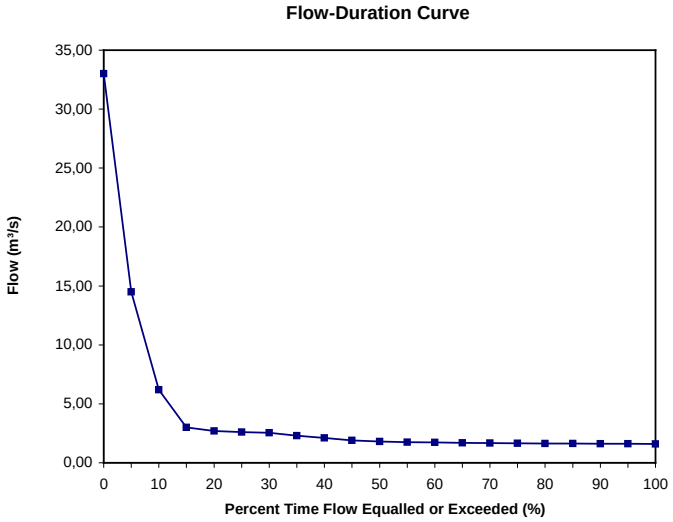
Complete Cost Analysis sheet

RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

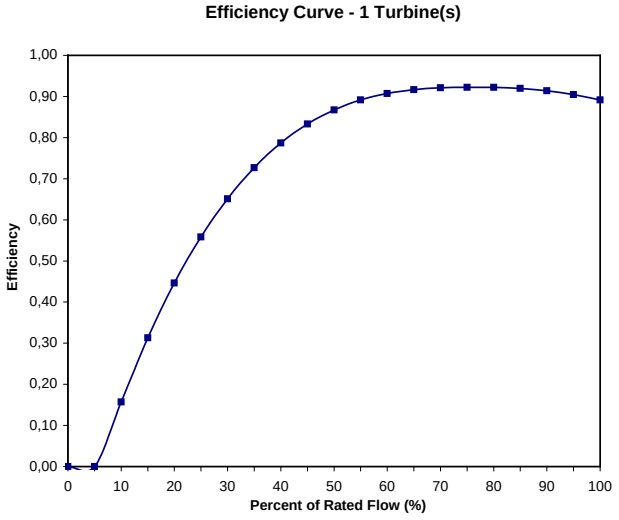
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



Return to Energy Model sheet

RETScreen® Cost Analysis - Small Hydro Project

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)		Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study		€ 318.400	1,00	**€ 318.400**	3,1%
Development		€ 342.400	1,00	€ 342.400	3,3%
Land rights				€ -	0,0%
Development Sub-total:				**€ 342.400**	3,3%
Engineering		€ 555.200	1,00	**€ 555.200**	5,4%
Energy Equipment		€ 1.864.000	1,00	**€ 1.864.000**	18,1%
Balance of Plant					
Access road		€ 342.400	1,00	€ 342.400	3,3%
Transmission line		€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer		€ 124.800	1,00	€ 124.800	1,2%
Penstock		€ -	1,00	€ -	0,0%
Canal		€ -	1,00	€ -	0,0%
Tunnel		€ -	1,00	€ -	0,0%
Civil works (other)		€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:		€ 6.136.000		**€ 6.136.000**	59,7%
Miscellaneous		€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP	Cost	€ -		€ -	0,0%
GHG validation and registration	Cost	€ -		€ -	0,0%
Miscellaneous Sub-total:				**€ 1.057.600**	10,3%
Initial Costs - Total (Formula Method)		€ 10.273.600		**€ 10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet?	Yes	Type of analysis:	User-defined
Potential CDM project?	Yes	Use simplified baseline methods?	No

Background Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	FYROM	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,545	8,0%	0,592

Does baseline change during project life? No

Proposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,592	0,000	24.125	14.292	0,0%	**14.292**

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		FYROM			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	14.292
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	300.123
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	428.748

Financial Parameters

Avoided cost of energy	€/kWh	0,0444	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.164.305
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	285.832
				Annual Savings - Total	**€**	**1.450.137**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	22,0%			
After-tax IRR and ROI	%	22,0%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	6,0			
Year-to-positive cash flow	yr	4,4	Project equity	€	7.191.520
Net Present Value - NPV	€	2.936.567	Project debt	€	3.082.080
Annual Life Cycle Savings	€	364.556	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,41	Debt service coverage	-	4,82

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	949.335	949.335	(3.160.105)
2	941.762	941.762	(2.218.344)
3	933.962	933.962	(1.284.382)
4	925.928	925.928	(358.454)
5	917.653	917.653	559.198
6	909.129	909.129	1.468.328
7	900.350	900.350	2.368.678
8	891.308	891.308	3.259.986
9	881.994	881.994	4.141.980
10	872.401	872.401	5.014.381
11	862.520	862.520	5.876.901
12	852.343	852.343	6.729.244
13	841.860	841.860	7.571.105
14	831.063	831.063	8.402.168
15	819.942	819.942	9.222.110
16	808.488	808.488	10.030.598
17	796.689	796.689	10.827.288
18	784.537	784.537	11.611.825
19	772.020	772.020	12.383.845
20	397.906	397.906	12.781.751
21	745.849	745.849	13.527.600
22	446.340	446.340	13.973.940
23	432.252	432.252	14.406.192
24	417.742	417.742	14.823.934
25	402.796	402.796	15.226.730
26	387.402	387.402	15.614.132
27	371.546	371.546	15.985.679
28	355.215	355.215	16.340.893
29	338.393	338.393	16.679.286
30	3.961.961	3.961.961	20.641.247

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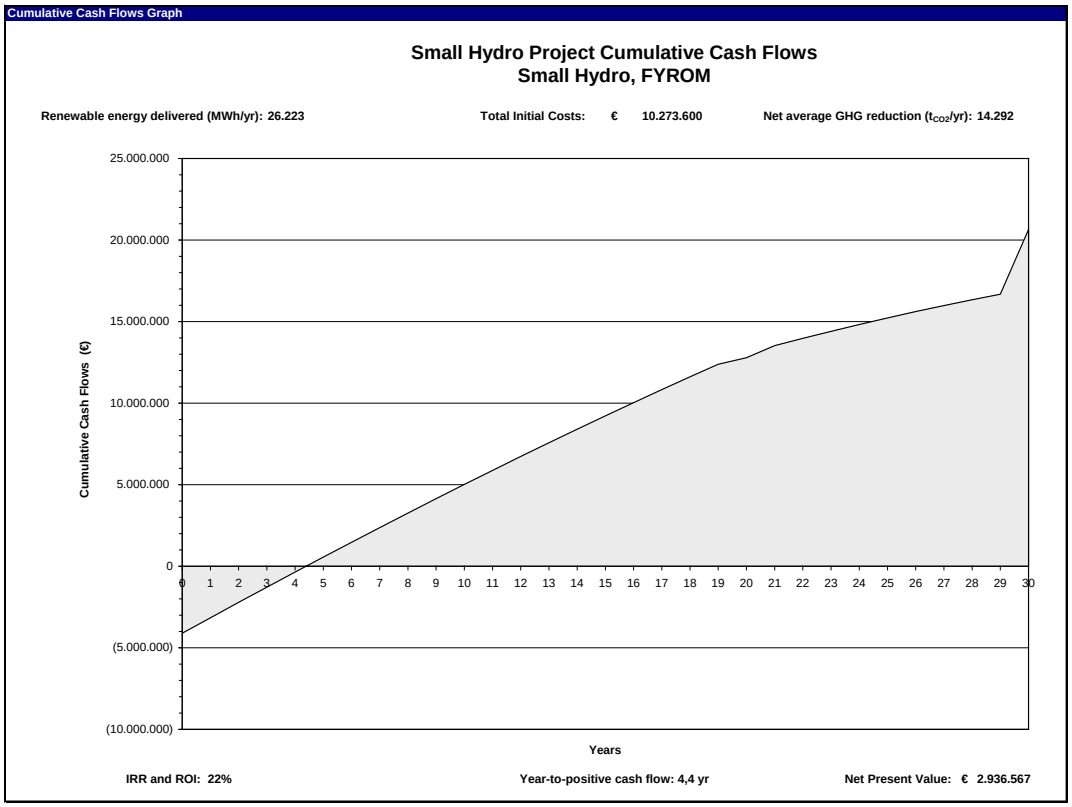

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		FYROM			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	14.292
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	300.123
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	428.748

Financial Parameters

Avoided cost of energy	€/kWh	0,0444	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.164.305
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	285.832
				Annual Savings - Total	**€**	**1.450.137**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	11,7%			
After-tax IRR and ROI	%	11,7%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8,5			
Year-to-positive cash flow	yr	7,8	Project equity	€	7.191.520
Net Present Value - NPV	€	(145.513)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(18.065)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,98	Debt service coverage	-	4,82

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	949.335	949.335	(6.242.185)
2	941.762	941.762	(5.300.424)
3	933.962	933.962	(4.366.462)
4	925.928	925.928	(3.440.534)
5	917.653	917.653	(2.522.882)
6	909.129	909.129	(1.613.752)
7	900.350	900.350	(713.402)
8	891.308	891.308	177.906
9	881.994	881.994	1.059.900
10	872.401	872.401	1.932.301
11	862.520	862.520	2.794.821
12	852.343	852.343	3.647.164
13	841.860	841.860	4.489.025
14	831.063	831.063	5.320.088
15	819.942	819.942	6.140.030
16	808.488	808.488	6.948.518
17	796.689	796.689	7.745.208
18	784.537	784.537	8.529.745
19	772.020	772.020	9.301.765
20	397.906	397.906	9.699.671
21	745.849	745.849	10.445.520
22	446.340	446.340	10.891.860
23	432.252	432.252	11.324.112
24	417.742	417.742	11.741.854
25	402.796	402.796	12.144.650
26	387.402	387.402	12.532.052
27	371.546	371.546	12.903.599
28	355.215	355.215	13.258.813
29	338.393	338.393	13.597.206
30	3.961.961	3.961.961	17.559.167

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RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No

Complete Financial Summary sheet

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RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		FYROM
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0444	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.164.305
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**1.164.305**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	7,4%			
After-tax IRR and ROI	%	7,4%			
Simple Payback	yr	11,2			
Year-to-positive cash flow	yr	11,6	Project equity	€	7.191.520
Net Present Value - NPV	€	(2.306.973)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(286.396)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,68	Debt service coverage	-	3,67

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	663.503	663.503	(6.528.017)
2	655.930	655.930	(5.872.087)
3	648.130	648.130	(5.223.957)
4	640.096	640.096	(4.583.861)
5	631.821	631.821	(3.952.040)
6	623.298	623.298	(3.328.743)
7	614.519	614.519	(2.714.224)
8	605.476	605.476	(2.108.748)
9	596.163	596.163	(1.512.585)
10	586.569	586.569	(926.016)
11	576.689	576.689	(349.327)
12	566.511	566.511	217.184
13	556.029	556.029	773.213
14	545.232	545.232	1.318.444
15	534.111	534.111	1.852.555
16	522.656	522.656	2.375.211
17	510.858	510.858	2.886.069
18	498.706	498.706	3.384.774
19	486.189	486.189	3.870.963
20	112.074	112.074	3.983.037
21	460.017	460.017	4.443.055
22	446.340	446.340	4.889.395
23	432.252	432.252	5.321.647
24	417.742	417.742	5.739.389
25	402.796	402.796	6.142.185
26	387.402	387.402	6.529.587
27	371.546	371.546	6.901.133
28	355.215	355.215	7.256.348
29	338.393	338.393	7.594.741
30	3.961.961	3.961.961	11.556.702

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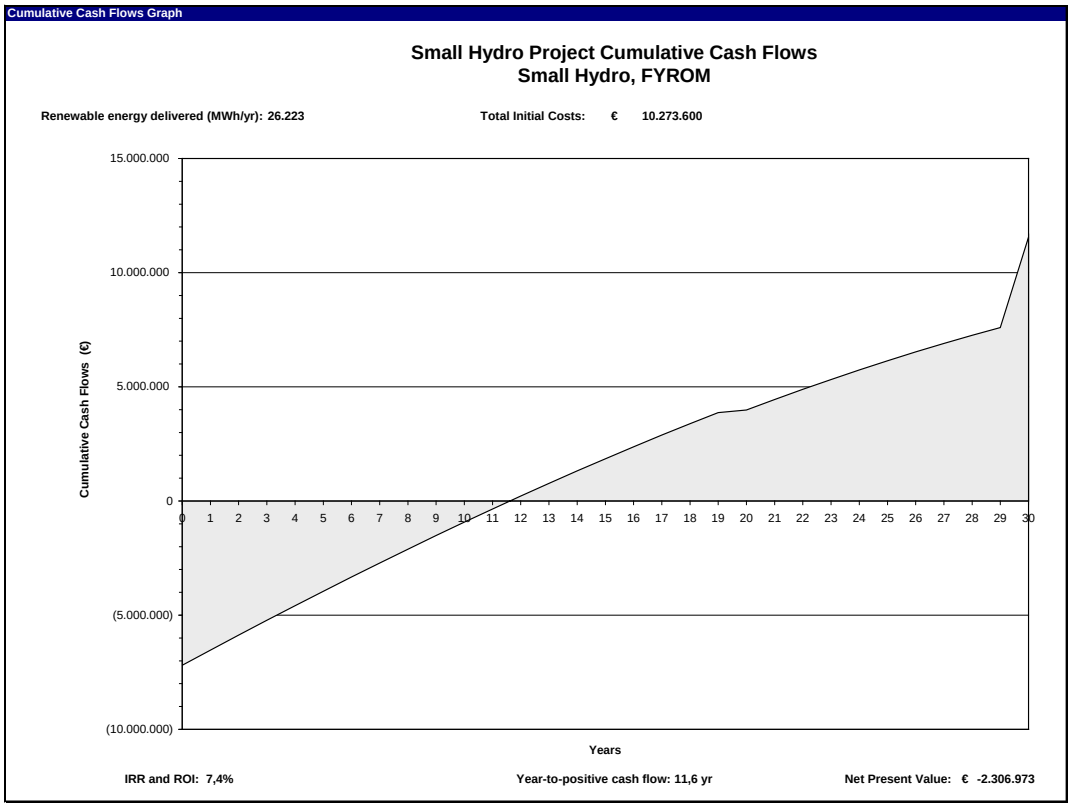
Cumulative Cash Flows Graph
Small Hydro Project Cumulative Cash Flows
Small Hydro, FYROM
Renewable energy delivered (MWh/yr): 26.223
Total Initial Costs: € 10.273.600
15.000.000
10.000.000
5.000.000
0
(5.000.000)
(10.000.000)
Cumulative Cash Flows (€)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Years
IRR and ROI: 7,4%
Year-to-positive cash flow: 11,6 yr
Net Present Value: € -2.306.973
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RETScreen® Energy Model - Small Hydro Project

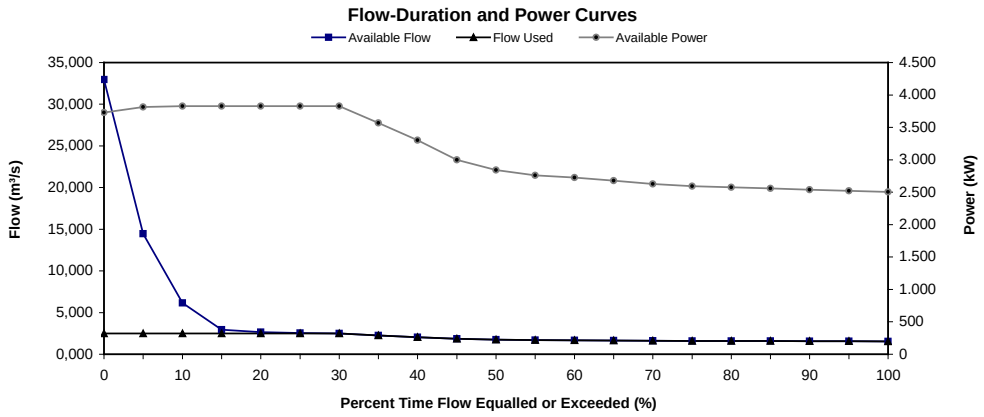
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		Small Hydro	*See Online Manual*
Project location		UKRAINE	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	*Complete Hydrology & Load sheet*
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	*Complete Equipment Data sheet*
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



Complete Cost Analysis sheet

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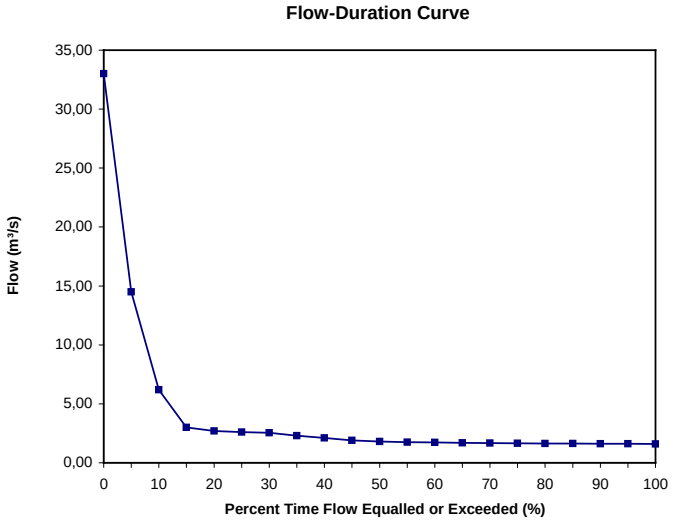
RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

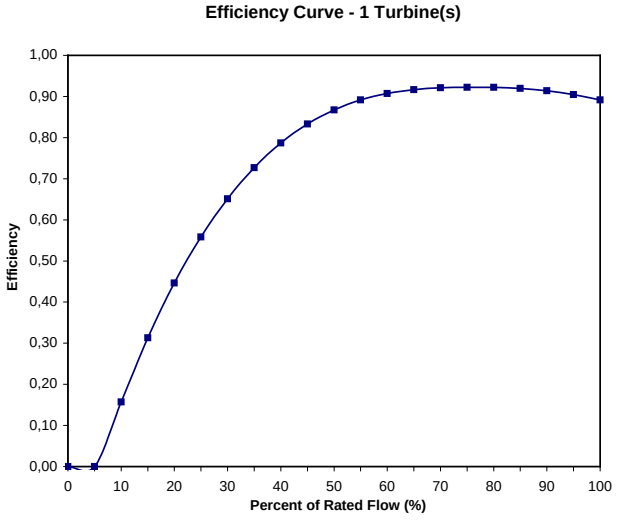
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



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RETScreen® Cost Analysis - Small Hydro Project

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)		Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study		€ 318.400	1,00	**€ 318.400**	3,1%
Development		€ 342.400	1,00	€ 342.400	3,3%
Land rights				€ -	0,0%
Development Sub-total:				**€ 342.400**	3,3%
Engineering		€ 555.200	1,00	**€ 555.200**	5,4%
Energy Equipment		€ 1.864.000	1,00	**€ 1.864.000**	18,1%
Balance of Plant					
Access road		€ 342.400	1,00	€ 342.400	3,3%
Transmission line		€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer		€ 124.800	1,00	€ 124.800	1,2%
Penstock		€ -	1,00	€ -	0,0%
Canal		€ -	1,00	€ -	0,0%
Tunnel		€ -	1,00	€ -	0,0%
Civil works (other)		€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:		€ 6.136.000		**€ 6.136.000**	59,7%
Miscellaneous		€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP	Cost	€ -		€ -	0,0%
GHG validation and registration	Cost	€ -		€ -	0,0%
Miscellaneous Sub-total:				**€ 1.057.600**	10,3%
Initial Costs - Total (Formula Method)		€ 10.273.600		**€ 10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet?	Yes	Type of analysis:	User-defined
Potential CDM project?	Yes	Use simplified baseline methods?	No

Background Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	UKRAINE	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,424	8,0%	0,461

Does baseline change during project life? No

Proposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,461	0,000	24.125	11.119	0,0%	**11.119**

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		UKRAINE			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	11.119
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	233.490
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	333.558

Financial Parameters

Avoided cost of energy	€/kWh	0,0270	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	708.023
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	222.372
				Annual Savings - Total	**€**	**930.395**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	7,2%			
After-tax IRR and ROI	%	7,2%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	10,5			
Year-to-positive cash flow	yr	10,5	Project equity	€	7.191.520
Net Present Value - NPV	€	(1.218.751)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(151.300)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,83	Debt service coverage	-	2,73

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	429.593	429.593	(3.679.847)
2	422.020	422.020	(3.257.827)
3	414.220	414.220	(2.843.607)
4	406.186	406.186	(2.437.421)
5	397.911	397.911	(2.039.510)
6	389.388	389.388	(1.650.122)
7	380.609	380.609	(1.269.514)
8	371.566	371.566	(897.948)
9	362.253	362.253	(535.695)
10	352.659	352.659	(183.036)
11	342.779	342.779	159.743
12	332.601	332.601	492.344
13	322.119	322.119	814.463
14	311.322	311.322	1.125.785
15	300.201	300.201	1.425.985
16	288.746	288.746	1.714.731
17	276.948	276.948	1.991.679
18	264.796	264.796	2.256.475
19	252.279	252.279	2.508.753
20	(121.836)	(121.836)	2.386.918
21	226.107	226.107	2.613.025
22	(9.942)	(9.942)	2.603.083
23	(24.030)	(24.030)	2.579.054
24	(38.540)	(38.540)	2.540.514
25	(53.486)	(53.486)	2.487.028
26	(68.880)	(68.880)	2.418.148
27	(84.736)	(84.736)	2.333.413
28	(101.067)	(101.067)	2.232.346
29	(117.889)	(117.889)	2.114.457
30	3.505.679	3.505.679	5.620.136

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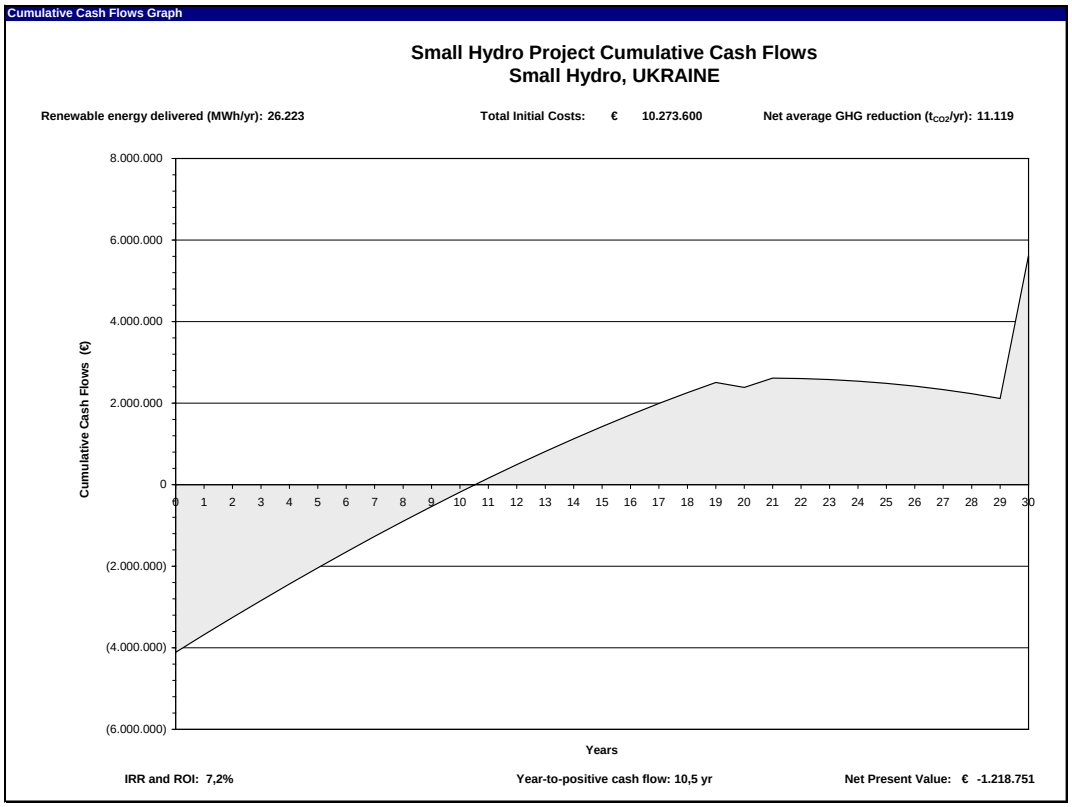

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		UKRAINE			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	11.119
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	233.490
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	333.558

Financial Parameters

Avoided cost of energy	€/kWh	0,0270	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	708.023
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	222.372
				Annual Savings - Total	**€**	**930.395**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	2,1%			
After-tax IRR and ROI	%	2,1%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	15,0			
Year-to-positive cash flow	yr	29,3	Project equity	€	7.191.520
Net Present Value - NPV	€	(4.300.831)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(533.921)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,40	Debt service coverage	-	2,73

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	429.593	429.593	(6.761.927)
2	422.020	422.020	(6.339.907)
3	414.220	414.220	(5.925.687)
4	406.186	406.186	(5.519.501)
5	397.911	397.911	(5.121.590)
6	389.388	389.388	(4.732.202)
7	380.609	380.609	(4.351.594)
8	371.566	371.566	(3.980.028)
9	362.253	362.253	(3.617.775)
10	352.659	352.659	(3.265.116)
11	342.779	342.779	(2.922.337)
12	332.601	332.601	(2.589.736)
13	322.119	322.119	(2.267.617)
14	311.322	311.322	(1.956.295)
15	300.201	300.201	(1.656.095)
16	288.746	288.746	(1.367.349)
17	276.948	276.948	(1.090.401)
18	264.796	264.796	(825.605)
19	252.279	252.279	(573.327)
20	(121.836)	(121.836)	(695.162)
21	226.107	226.107	(469.055)
22	(9.942)	(9.942)	(478.997)
23	(24.030)	(24.030)	(503.026)
24	(38.540)	(38.540)	(541.566)
25	(53.486)	(53.486)	(595.052)
26	(68.880)	(68.880)	(663.932)
27	(84.736)	(84.736)	(748.667)
28	(101.067)	(101.067)	(849.734)
29	(117.889)	(117.889)	(967.623)
30	3.505.679	3.505.679	2.538.056

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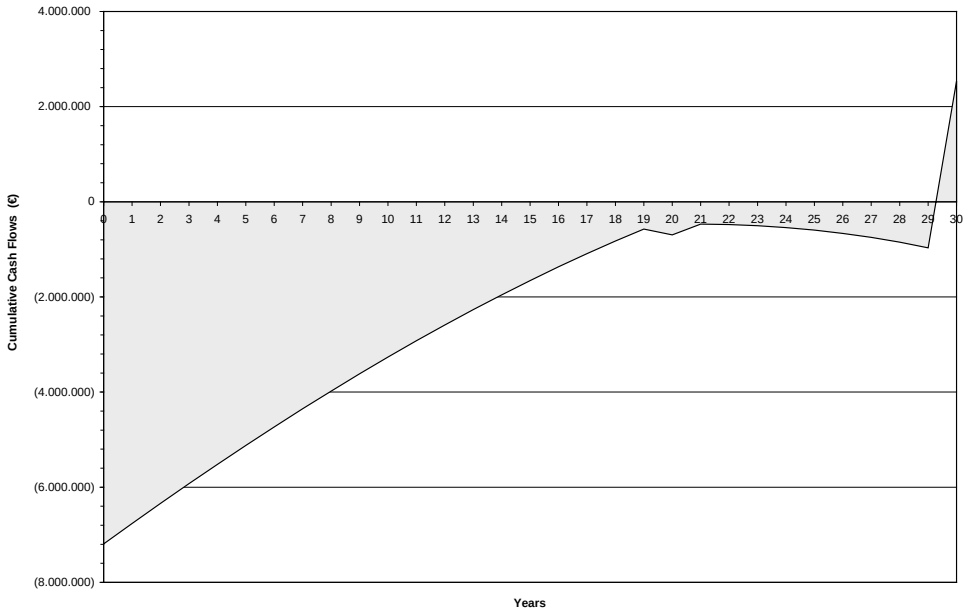
Cumulative Cash Flows Graph

Small Hydro Project Cumulative Cash Flows
Small Hydro, UKRAINE

Renewable energy delivered (MWh/yr): 26.223 **Total Initial Costs: € 10.273.600** **Net average GHG reduction (t_{CO2}/yr): 11.119**



IRR and ROI: 2,1% **Year-to-positive cash flow: 29,3 yr** **Net Present Value: € -4.300.831**

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RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No *Complete Financial Summary sheet*

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RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		UKRAINE
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0270	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	708.023
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**708.023**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	-1,6%			
After-tax IRR and ROI	%	-1,6%			
Simple Payback	yr	22,2			
Year-to-positive cash flow	yr	more than 30	Project equity	€	7.191.520
Net Present Value - NPV	€	(5.982.407)	Project debt	€	3.082.080
Annual Life Cycle Savings	€	(742.678)	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	0,17	Debt service coverage	-	1,80

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	207.221	207.221	(6.984.299)
2	199.648	199.648	(6.784.651)
3	191.848	191.848	(6.592.802)
4	183.814	183.814	(6.408.988)
5	175.539	175.539	(6.233.449)
6	167.016	167.016	(6.066.433)
7	158.237	158.237	(5.908.196)
8	149.194	149.194	(5.759.002)
9	139.881	139.881	(5.619.121)
10	130.288	130.288	(5.488.834)
11	120.407	120.407	(5.368.427)
12	110.230	110.230	(5.258.197)
13	99.747	99.747	(5.158.450)
14	88.950	88.950	(5.069.501)
15	77.829	77.829	(4.991.672)
16	66.374	66.374	(4.925.298)
17	54.576	54.576	(4.870.722)
18	42.424	42.424	(4.828.298)
19	29.907	29.907	(4.798.391)
20	(344.208)	(344.208)	(5.142.599)
21	3.736	3.736	(5.138.863)
22	(9.942)	(9.942)	(5.148.805)
23	(24.030)	(24.030)	(5.172.834)
24	(38.540)	(38.540)	(5.211.374)
25	(53.486)	(53.486)	(5.264.860)
26	(68.880)	(68.880)	(5.333.740)
27	(84.736)	(84.736)	(5.418.475)
28	(101.067)	(101.067)	(5.519.542)
29	(117.889)	(117.889)	(5.637.431)
30	3.505.679	3.505.679	(2.131.752)

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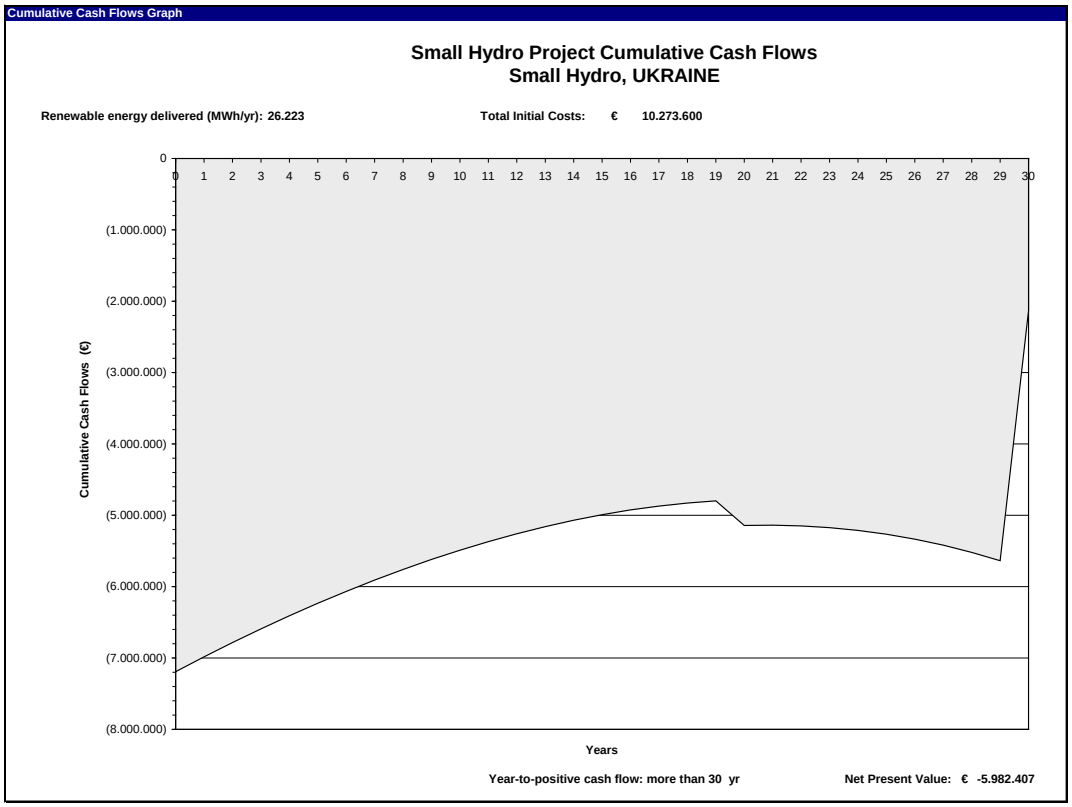
Cumulative Cash Flows Graph
Small Hydro Project Cumulative Cash Flows
Small Hydro, UKRAINE
Renewable energy delivered (MWh/yr): 26.223
Total Initial Costs: € 10.273.600
0
(1.000.000)
(2.000.000)
(3.000.000)
(4.000.000)
(5.000.000)
(6.000.000)
(7.000.000)
(8.000.000)
Cumulative Cash Flows (€)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Years
Year-to-positive cash flow: more than 30 yr
Net Present Value: € -5.982.407
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RETScreen® Energy Model - Small Hydro Project

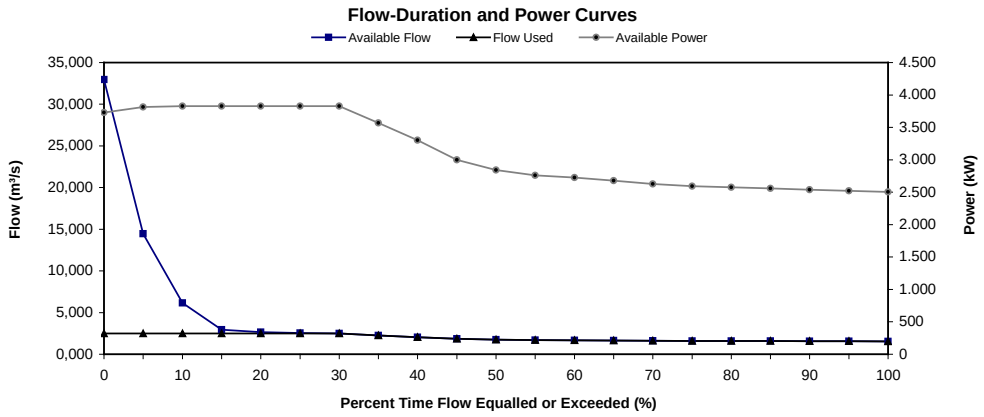
Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		Small Hydro	See Online Manual
Project location		ROMANIA	
Latitude of project location	°N		-90.00 to 90.00
Longitude of project location	°E		-180.00 to 180.00
Gross head	m	200,00	
Maximum tailwater effect	m	5,00	
Residual flow	m³/s	0,05	Complete Hydrology & Load sheet
Firm flow	m³/s	1,56	

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Design flow	m³/s	2,500	
Turbine type	-	Francis	Complete Equipment Data sheet
Number of turbines	turbine	1	
Turbine peak efficiency	%	92,3%	
Turbine efficiency at design flow	%	89,2%	
Maximum hydraulic losses	%	5%	2% to 7%
Generator efficiency	%	95%	93% to 97%
Transformer losses	%	1%	1% to 2%
Parasitic electricity losses	%	2%	1% to 3%
Annual downtime losses	%	4%	2% to 7%

Annual Energy Production		Estimate	Notes/Range
Small hydro plant capacity	kW	3.829	
	MW	3,829	
Small hydro plant firm capacity	kW	**2.522**	
Available flow adjustment factor	-	1,00	
Small hydro plant capacity factor	%	78%	40% to 95%
Renewable energy delivered	MWh	**26.223**	
	GJ	94.403	



Complete Cost Analysis sheet

Version 3.2

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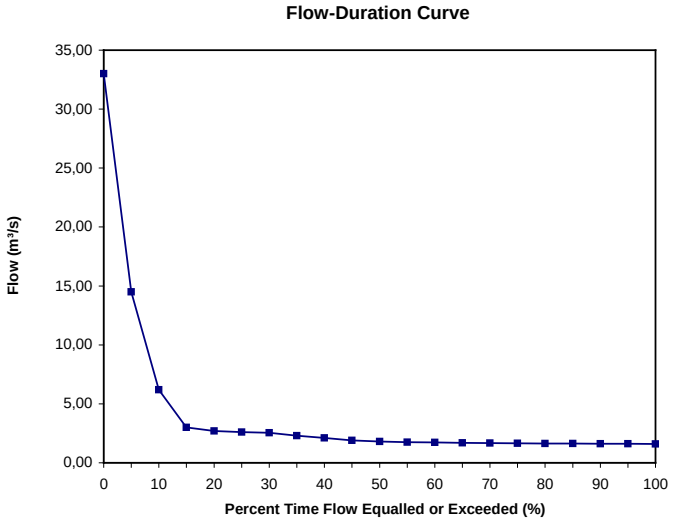
RETScreen® Hydrology Analysis and Load Calculation - Small Hydro Project

Hydrology Analysis		Estimate	Notes/Range
Project type		Run-of-river	
Hydrology method		User-defined	
Hydrology Parameters			
Residual flow	m³/s	0,05	
Percent time firm flow available	%	95%	90% to 100%
Firm flow	m³/s	1,56	

Flow-Duration Curve Data

Time (%)	Flow (m³/s)
0%	33,00
5%	14,50
10%	6,20
15%	3,00
20%	2,70
25%	2,60
30%	2,55
35%	2,30
40%	2,10
45%	1,90
50%	1,80
55%	1,75
60%	1,73
65%	1,70
70%	1,67
75%	1,65
80%	1,64
85%	1,63
90%	1,62
95%	1,61
100%	1,60



Load Characteristics	Estimate	Notes/Range
Grid type	Central-grid	

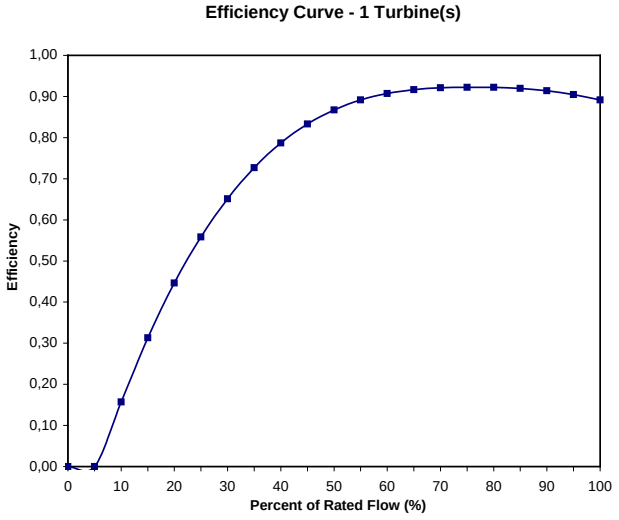
Return to Energy Model sheet

RETScreen® Equipment Data - Small Hydro Project

Small Hydro Turbine Characteristics		Estimate	Notes/Range
Gross head	m	200,00	
Design flow	m³/s	2,500	
Turbine type	-	Francis	See Product Database
Turbine efficiency curve data source	-	Standard	
Number of turbines	turbine	1	
Small hydro turbine manufacturer		ABC Ltd.	
Small hydro turbine model		model XYZ	
Turbine manufacture/design coefficient	-	4,5	2.8 to 6.1; Default = 4.5
Efficiency adjustment	%	0%	-5% to 5%
Turbine peak efficiency	%	92,3%	
Flow at peak efficiency	m³/s	2,0	
Turbine efficiency at design flow	%	89,2%	

Turbine Efficiency Curve Data

Flow (%)	Turbine efficiency	Turbines running #	Combined turbine efficiency
0%	0,00	0	0,00
5%	0,00	1	0,00
10%	0,16	1	0,16
15%	0,31	1	0,31
20%	0,45	1	0,45
25%	0,56	1	0,56
30%	0,65	1	0,65
35%	0,73	1	0,73
40%	0,79	1	0,79
45%	0,83	1	0,83
50%	0,87	1	0,87
55%	0,89	1	0,89
60%	0,91	1	0,91
65%	0,92	1	0,92
70%	0,92	1	0,92
75%	0,92	1	0,92
80%	0,92	1	0,92
85%	0,92	1	0,92
90%	0,91	1	0,91
95%	0,90	1	0,90
100%	0,89	1	0,89



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RETScreen® Cost Analysis - Small Hydro Project

Costing method: Formula | Currency: Euro symbol | Cost references: None

Formula Costing Method			Notes/Range
Input Parameters			
Project country		Enter name	
Local vs. Canadian equipment costs ratio	-	0,80	
Local vs. Canadian fuel costs ratio	-	1,00	
Local vs. Canadian labour costs ratio	-	0,80	
Equipment manufacture cost coefficient	-	1,00	0.50 to 1.00
Exchange rate	€/CAD	1,60	
Cold climate?	yes/no	No	
Number of turbines	turbine	1	
Flow per turbine	m³/s	2,5	
Approx. turbine runner diameter (per unit)	m	0,7	
Project classification:			
Suggested classification	-	Mini	
Selected classification	-	Small	
Existing dam?	yes/no	No	
New dam crest length	m		
Rock at dam site?	yes/no	No	
Maximum hydraulic losses	%	5%	
Intake and miscellaneous losses	%	1%	1% to 5%
Access road required?	yes/no	Yes	
Length	km	5,0	
Tote road only?	yes/no	Yes	
Difficulty of terrain	-	3,0	1.0 to 6.0
Tunnel required?	yes/no	No	
Canal required?	yes/no	No	
Penstock required?	yes/no	No	
Distance to borrow pits	km	3,0	
Transmission line			
Length	km	10,0	
Difficulty of terrain	-	1,0	1.0 to 2.0
Voltage	kV	44,0	
Interest rate	%	5,0%	

Initial Costs (Formula Method)		Cost (local currency)	Adjustment Factor	Amount (local currency)	Relative Costs
Feasibility Study		€ 318.400	1,00	**€ 318.400**	3,1%
Development		€ 342.400	1,00	€ 342.400	3,3%
Land rights				€ -	0,0%
Development Sub-total:				**€ 342.400**	3,3%
Engineering		€ 555.200	1,00	**€ 555.200**	5,4%
Energy Equipment		€ 1.864.000	1,00	**€ 1.864.000**	18,1%
Balance of Plant					
Access road		€ 342.400	1,00	€ 342.400	3,3%
Transmission line		€ 556.800	1,00	€ 556.800	5,4%
Substation and transformer		€ 124.800	1,00	€ 124.800	1,2%
Penstock		€ -	1,00	€ -	0,0%
Canal		€ -	1,00	€ -	0,0%
Tunnel		€ -	1,00	€ -	0,0%
Civil works (other)		€ 5.112.000	1,00	€ 5.112.000	49,8%
Balance of Plant Sub-total:		€ 6.136.000		**€ 6.136.000**	59,7%
Miscellaneous		€ 1.057.600	1,00	€ 1.057.600	10,3%
GHG baseline study and MP	Cost	€ -		€ -	0,0%
GHG validation and registration	Cost	€ -		€ -	0,0%
Miscellaneous Sub-total:				**€ 1.057.600**	10,3%
Initial Costs - Total (Formula Method)		€ 10.273.600		**€ 10.273.600**	100,0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
Land lease	project	1	€ -	€ -		-	-
Property taxes	%	0,0%	€ 10.273.600	€ -		-	-
Water rental	kW	3.829	€ -	€ -		-	-
Insurance premium	%	0,40%	€ 10.273.600	€ 41.094		-	-
Transmission line maintenance	%	5,0%	€ 681.600	€ 34.080		-	-
Spare parts	%	0,50%	€ 10.273.600	€ 51.368		-	-
O&M labour	p-yr	2,00	€ 35.000	€ 70.000		-	-
GHG monitoring and verification	project	0	€ -	€ -		-	-
Travel and accommodation	p-trip	6	€ 1.000	€ 6.000		-	-
General and administrative	%	10%	€ 202.542	€ 20.254		-	-
Other - O&M	Cost	0	€ -	€ -		-	-

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet?	Yes	Type of analysis:	User-defined
Potential CDM project?	Yes	Use simplified baseline methods?	No

Background Information

Project Information

Project name	Small Hydro	Project capacity	2,52 MW
Project location	ROMANIA	Grid type	Central-grid

Base Case Electricity System (Baseline)

Fuel type	GHG emission factor	T & D losses	Base case GHG emission factor
	(tCO2/MWh)	(%)	(t_{CO2}/MWh)
Electricity system			
Diesel (#2 oil)	0,423	8,0%	0,460

Does baseline change during project life? No

Proposed Case Electricity System (Small Hydro Project)

Fuel type	Proposed case GHG emission factor	T & D losses
	(tCO2/MWh)	(%)
Electricity system		
Small hydro	0,000	8,0%

GHG Emission Reduction Summary

	Base case GHG emission factor	Proposed case GHG emission factor	End-use annual energy delivered	Gross annual GHG emission reduction	GHG credits transaction fee	Net annual GHG emission reduction
	(tCO2/MWh)	(tCO2/MWh)	(MWh)	(t_{CO2})	(%)	(t_{CO2})
Electricity system	0,460	0,000	24.125	11.092	0,0%	**11.092**

Complete Financial Summary sheet

RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		ROMANIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	11.092
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	232.940
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	332.771

Financial Parameters

Avoided cost of energy	€/kWh	0,0684	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.793.659
				Capacity savings/income	€	-
Incentives/Grants		€	3.082.080			
				GHG reduction income - 21 yrs	€	221.847
				Annual Savings - Total	**€**	**2.015.507**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	36,3%			
After-tax IRR and ROI	%	36,3%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	4,1			
Year-to-positive cash flow	yr	2,7	Project equity	€	7.191.520
Net Present Value - NPV	€	7.522.281	Project debt	€	3.082.080
Annual Life Cycle Savings	€	933.843	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	2,05	Debt service coverage	-	7,10

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(4.109.440)	(4.109.440)	(4.109.440)
1	1.514.704	1.514.704	(2.594.736)
2	1.507.132	1.507.132	(1.087.604)
3	1.499.332	1.499.332	411.728
4	1.491.298	1.491.298	1.903.025
5	1.483.022	1.483.022	3.386.048
6	1.474.499	1.474.499	4.860.547
7	1.465.720	1.465.720	6.326.267
8	1.456.678	1.456.678	7.782.945
9	1.447.364	1.447.364	9.230.309
10	1.437.771	1.437.771	10.668.080
11	1.427.890	1.427.890	12.095.970
12	1.417.713	1.417.713	13.513.683
13	1.407.230	1.407.230	14.920.913
14	1.396.433	1.396.433	16.317.346
15	1.385.312	1.385.312	17.702.658
16	1.373.858	1.373.858	19.076.516
17	1.362.059	1.362.059	20.438.575
18	1.349.907	1.349.907	21.788.482
19	1.337.390	1.337.390	23.125.872
20	963.276	963.276	24.089.148
21	1.311.219	1.311.219	25.400.367
22	1.075.694	1.075.694	26.476.061
23	1.061.606	1.061.606	27.537.668
24	1.047.096	1.047.096	28.584.764
25	1.032.150	1.032.150	29.616.914
26	1.016.756	1.016.756	30.633.670
27	1.000.900	1.000.900	31.634.571
28	984.569	984.569	32.619.140
29	967.747	967.747	33.586.887
30	4.591.315	4.591.315	38.178.202

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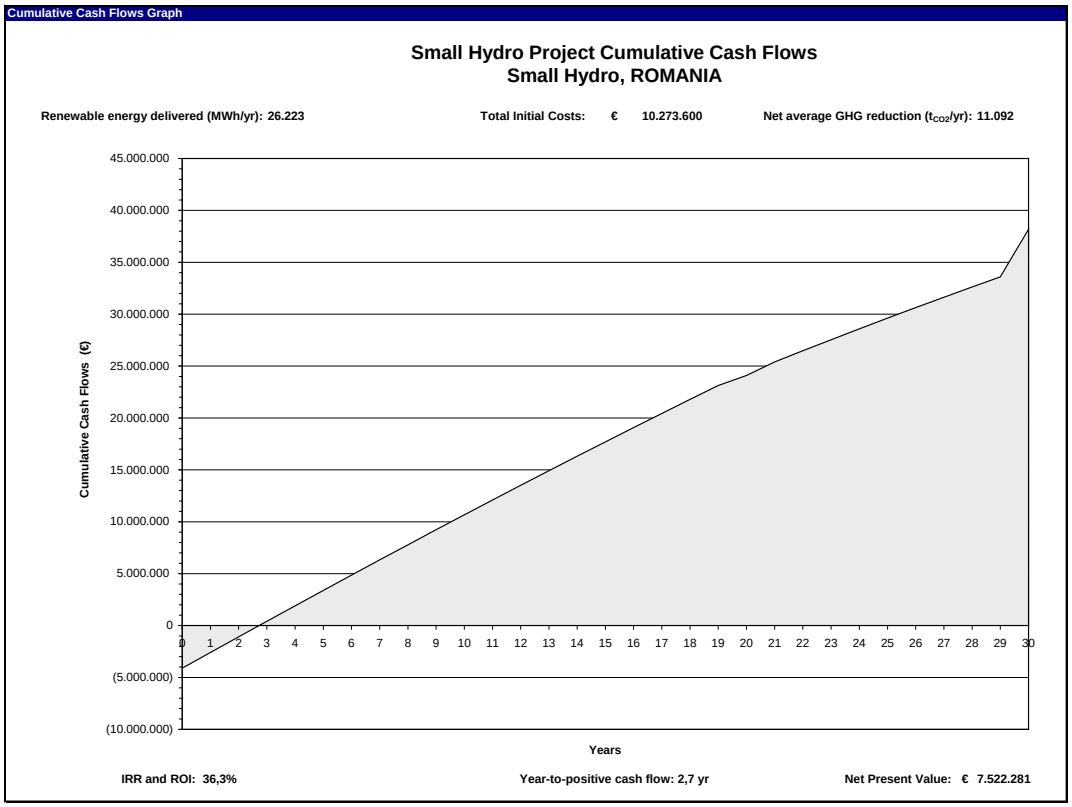

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RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro			
Project location		ROMANIA			
Renewable energy delivered	MWh	26.223	Net GHG reduction	t_{CO2}/yr	11.092
Excess RE available	MWh	-			
Firm RE capacity	kW	2.522	Net GHG emission reduction - 21 yrs	t_{CO2}	232.940
Grid type		Central-grid	Net GHG emission reduction - 30 yrs	t_{CO2}	332.771

Financial Parameters

Avoided cost of energy	€/kWh	0,0684	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
GHG emission reduction credit	€/t_{CO2}	20,0	Income tax analysis?	yes/no	No
GHG reduction credit duration	yr	21			
GHG credit escalation rate	%	0,0%			
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.793.659
				Capacity savings/income	€	-
Incentives/Grants		€				
				GHG reduction income - 21 yrs	€	221.847
				Annual Savings - Total	**€**	**2.015.507**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	20,4%			
After-tax IRR and ROI	%	20,4%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	5,8			
Year-to-positive cash flow	yr	4,8	Project equity	€	7.191.520
Net Present Value - NPV	€	4.440.201	Project debt	€	3.082.080
Annual Life Cycle Savings	€	551.223	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,62	Debt service coverage	-	7,10

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	1.514.704	1.514.704	(5.676.816)
2	1.507.132	1.507.132	(4.169.684)
3	1.499.332	1.499.332	(2.670.352)
4	1.491.298	1.491.298	(1.179.055)
5	1.483.022	1.483.022	303.968
6	1.474.499	1.474.499	1.778.467
7	1.465.720	1.465.720	3.244.187
8	1.456.678	1.456.678	4.700.865
9	1.447.364	1.447.364	6.148.229
10	1.437.771	1.437.771	7.586.000
11	1.427.890	1.427.890	9.013.890
12	1.417.713	1.417.713	10.431.603
13	1.407.230	1.407.230	11.838.833
14	1.396.433	1.396.433	13.235.266
15	1.385.312	1.385.312	14.620.578
16	1.373.858	1.373.858	15.994.436
17	1.362.059	1.362.059	17.356.495
18	1.349.907	1.349.907	18.706.402
19	1.337.390	1.337.390	20.043.792
20	963.276	963.276	21.007.068
21	1.311.219	1.311.219	22.318.287
22	1.075.694	1.075.694	23.393.981
23	1.061.606	1.061.606	24.455.588
24	1.047.096	1.047.096	25.502.684
25	1.032.150	1.032.150	26.534.834
26	1.016.756	1.016.756	27.551.590
27	1.000.900	1.000.900	28.552.491
28	984.569	984.569	29.537.060
29	967.747	967.747	30.504.807
30	4.591.315	4.591.315	35.096.122

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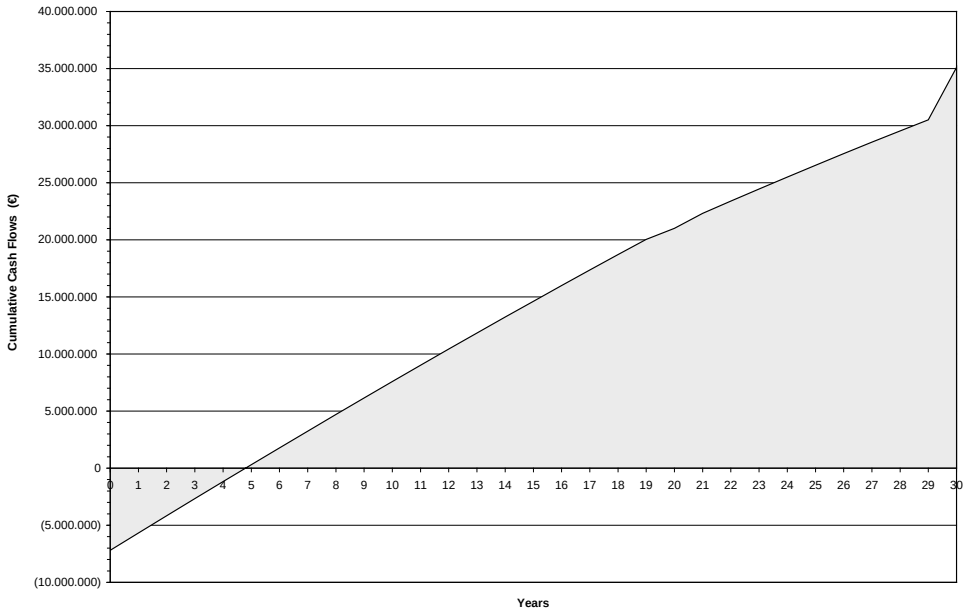
Cumulative Cash Flows Graph

Small Hydro Project Cumulative Cash Flows
Small Hydro, ROMANIA

Renewable energy delivered (MWh/yr): 26.223 **Total Initial Costs: € 10.273.600** **Net average GHG reduction (t_{CO2}/yr): 11.092**



IRR and ROI: 20,4% **Year-to-positive cash flow: 4,8 yr** **Net Present Value: € 4.440.201**

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RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Small Hydro Project

Use GHG analysis sheet? No *Complete Financial Summary sheet*

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RETScreen® Financial Summary - Small Hydro Project

Annual Energy Balance

Project name		Small Hydro
Project location		ROMANIA
Renewable energy delivered	MWh	26.223
Excess RE available	MWh	-
Firm RE capacity	kW	2.522
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	€/kWh	0,0684	Debt ratio	%	30,0%
RE production credit	€/kWh	-	Debt interest rate	%	7,0%
			Debt term	yr	30
			Income tax analysis?	yes/no	No
Avoided cost of capacity	€/kW-yr	-			
Energy cost escalation rate	%				
Inflation	%	3,0%			
Discount rate	%	12,0%			
Project life	yr	30			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3,1%	€	318.400	O&M	€	245.076
Development	3,3%	€	342.400			
Engineering	5,4%	€	555.200	Debt payments - 30 yrs	€	248.374
Energy equipment	18,1%	€	1.864.000	**Annual Costs and Debt - Total**	**€**	**493.450**
Balance of plant	59,7%	€	6.136.000			
Miscellaneous	10,3%	€	1.057.600	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**€**	**10.273.600**	Energy savings/income	€	1.793.659
				Capacity savings/income	€	-
Incentives/Grants		€				
				Annual Savings - Total	**€**	**1.793.659**
Periodic Costs (Credits)						
Turbine overhaul		€	200.000	Schedule yr # 20		
		€	-			
		€	-			
End of project life - Credit		€	(1.500.000)	Schedule yr # 30		

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	17,2%			
After-tax IRR and ROI	%	17,2%			
Simple Payback	yr	6,6			
Year-to-positive cash flow	yr	5,6	Project equity	€	7.191.520
Net Present Value - NPV	€	2.762.591	Project debt	€	3.082.080
Annual Life Cycle Savings	€	342.958	Debt payments	€/yr	248.374
Benefit-Cost (B-C) ratio	-	1,38	Debt service coverage	-	6,21

Yearly Cash Flows

Year	Pre-tax	After-tax	Cumulative
#	€	€	€
0	(7.191.520)	(7.191.520)	(7.191.520)
1	1.292.857	1.292.857	(5.898.663)
2	1.285.284	1.285.284	(4.613.379)
3	1.277.484	1.277.484	(3.335.894)
4	1.269.450	1.269.450	(2.066.444)
5	1.261.175	1.261.175	(805.269)
6	1.252.652	1.252.652	447.383
7	1.243.873	1.243.873	1.691.255
8	1.234.830	1.234.830	2.926.086
9	1.225.517	1.225.517	4.151.602
10	1.215.924	1.215.924	5.367.526
11	1.206.043	1.206.043	6.573.569
12	1.195.865	1.195.865	7.769.434
13	1.185.383	1.185.383	8.954.817
14	1.174.586	1.174.586	10.129.403
15	1.163.465	1.163.465	11.292.868
16	1.152.010	1.152.010	12.444.878
17	1.140.212	1.140.212	13.585.090
18	1.128.060	1.128.060	14.713.150
19	1.115.543	1.115.543	15.828.693
20	741.428	741.428	16.570.121
21	1.089.372	1.089.372	17.659.493
22	1.075.694	1.075.694	18.735.187
23	1.061.606	1.061.606	19.796.793
24	1.047.096	1.047.096	20.843.889
25	1.032.150	1.032.150	21.876.040
26	1.016.756	1.016.756	22.892.796
27	1.000.900	1.000.900	23.893.696
28	984.569	984.569	24.878.265
29	967.747	967.747	25.846.012
30	4.591.315	4.591.315	30.437.327

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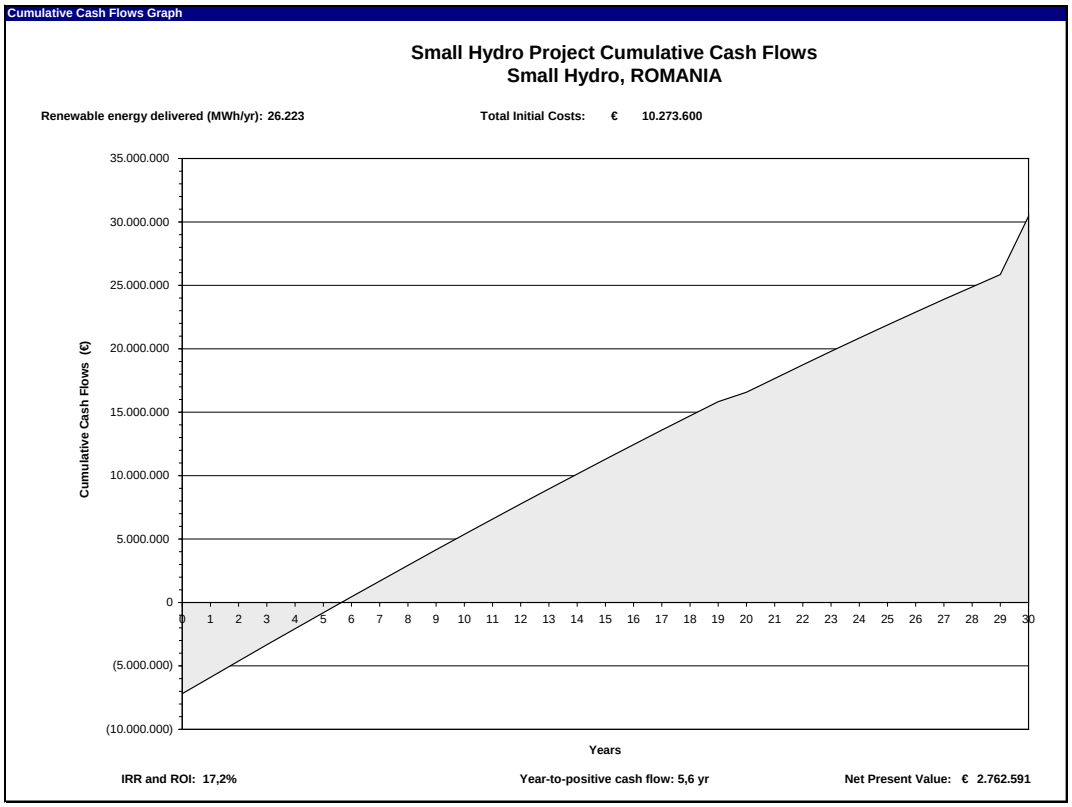
Cumulative Cash Flows Graph
Small Hydro Project Cumulative Cash Flows
Small Hydro, ROMANIA
Renewable energy delivered (MWh/yr): 26.223
Total Initial Costs: € 10.273.600
35.000.000
30.000.000
25.000.000
20.000.000
15.000.000
10.000.000
5.000.000
0
(5.000.000)
(10.000.000)
Cumulative Cash Flows (€)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Years
IRR and ROI: 17,2%
Year-to-positive cash flow: 5,6 yr
Net Present Value: € 2.762.591
Version 3.2
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