X SICEL 2021

Transición energética en la 4ta revolución industrial

Universidad Tecnológica de Pereira

UNIVERSIDAD NACIONAL DE COLOMBIA

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Transición energética en la 4ta revolución industrial

Technical and economic approach of electricity generation using the Medellin (AMVA) aqueduct network.

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Semillero de investigación en transición energética y micro generación

Contents

I. Introduction

- General idea
- Location
- Network of aqueduct
- Case of study

II. Theoretical aspects

$$hf = 10{,}67 * \frac{Q}{C} * \frac{L}{D^{4,87}}$$

Friction loss (1)

$$P = \rho * g * Q * h$$

Hydraulic power (2)

$$Q = V * A$$

Flow (3)

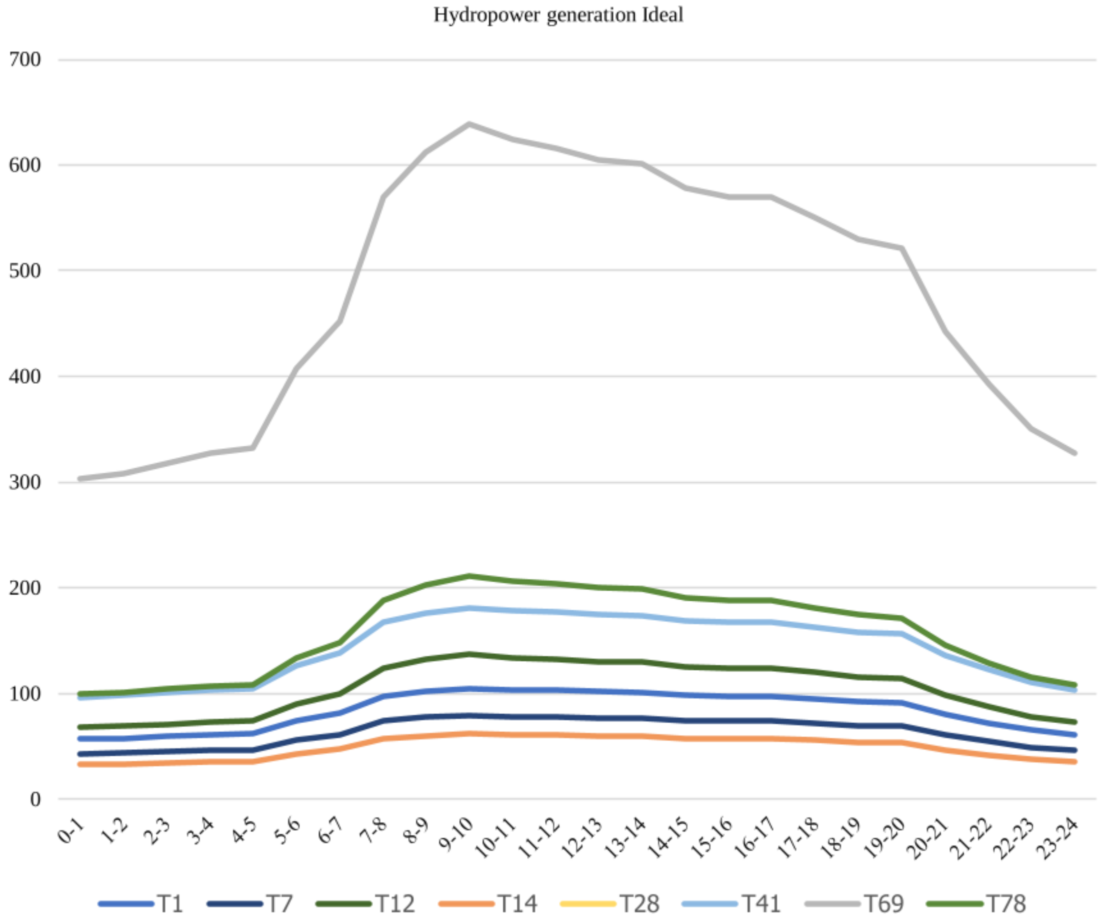
$$V = \frac{x\% * Vmax}{138\%}$$

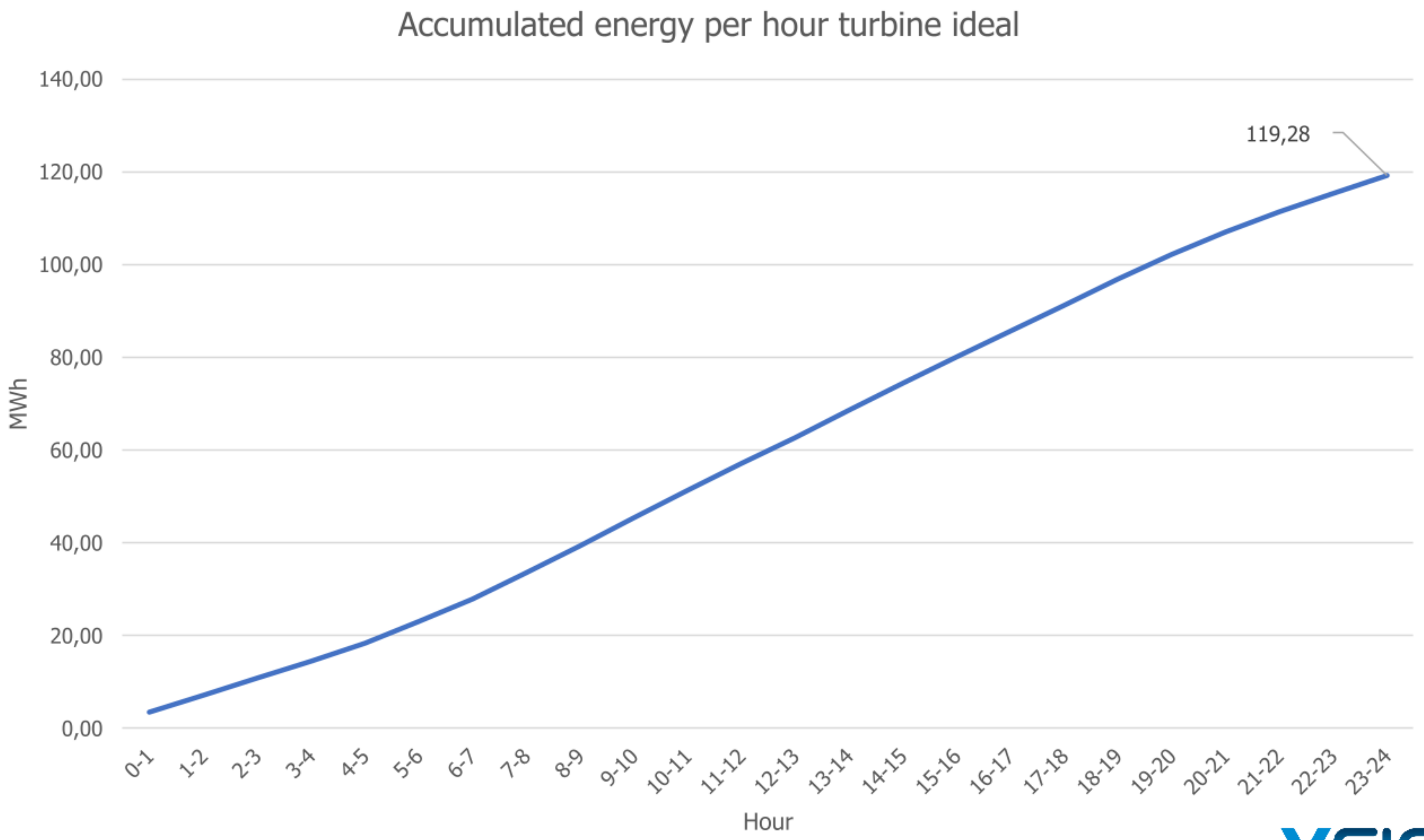
Speed interpolation (4)

III. Proposed methodology

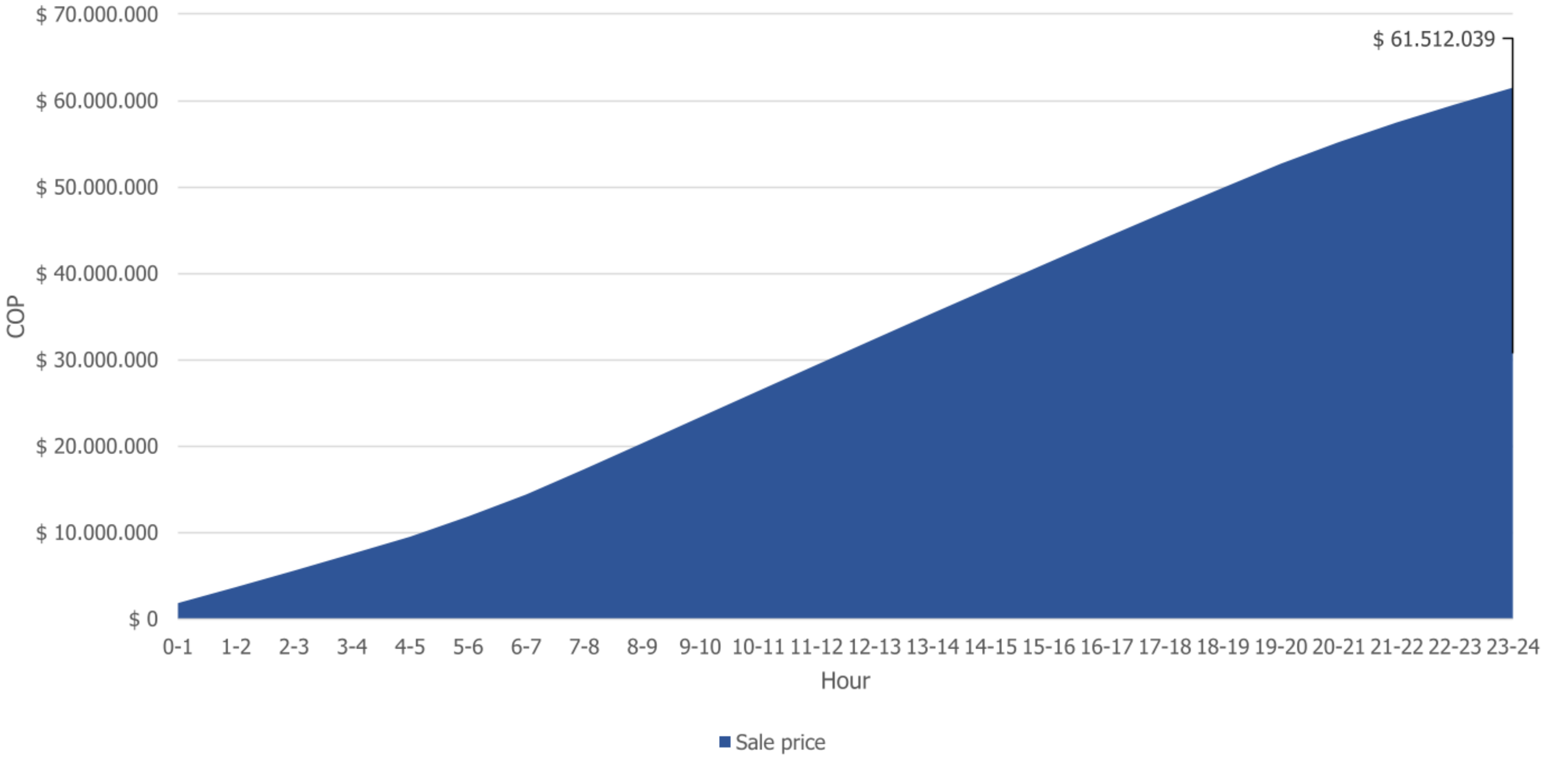
1. Identification of key points
2. Pipe measurement
3. Friction loss calculation
4. Hydraulic power calculation
5. Energy production cost calculation
6. Energy sale calculation

IV. Results

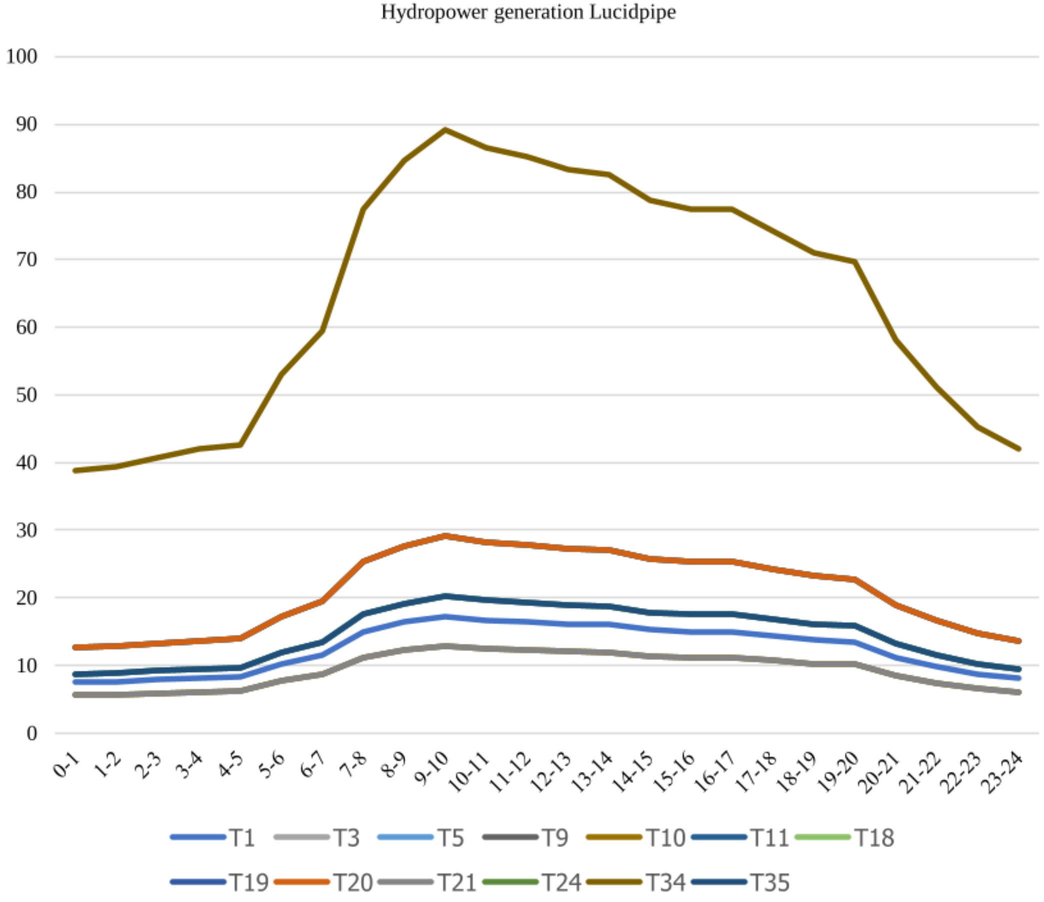

Hydropower generation Ideal
700
600
500
400
300
200
100
0
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
T1
T7
T12
T14
T28
T41
T69
T78


Accumulated energy per hour turbine ideal
140,00
120,00
100,00
80,00
60,00
40,00
20,00
0,00
MWh
119,28
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
Hour

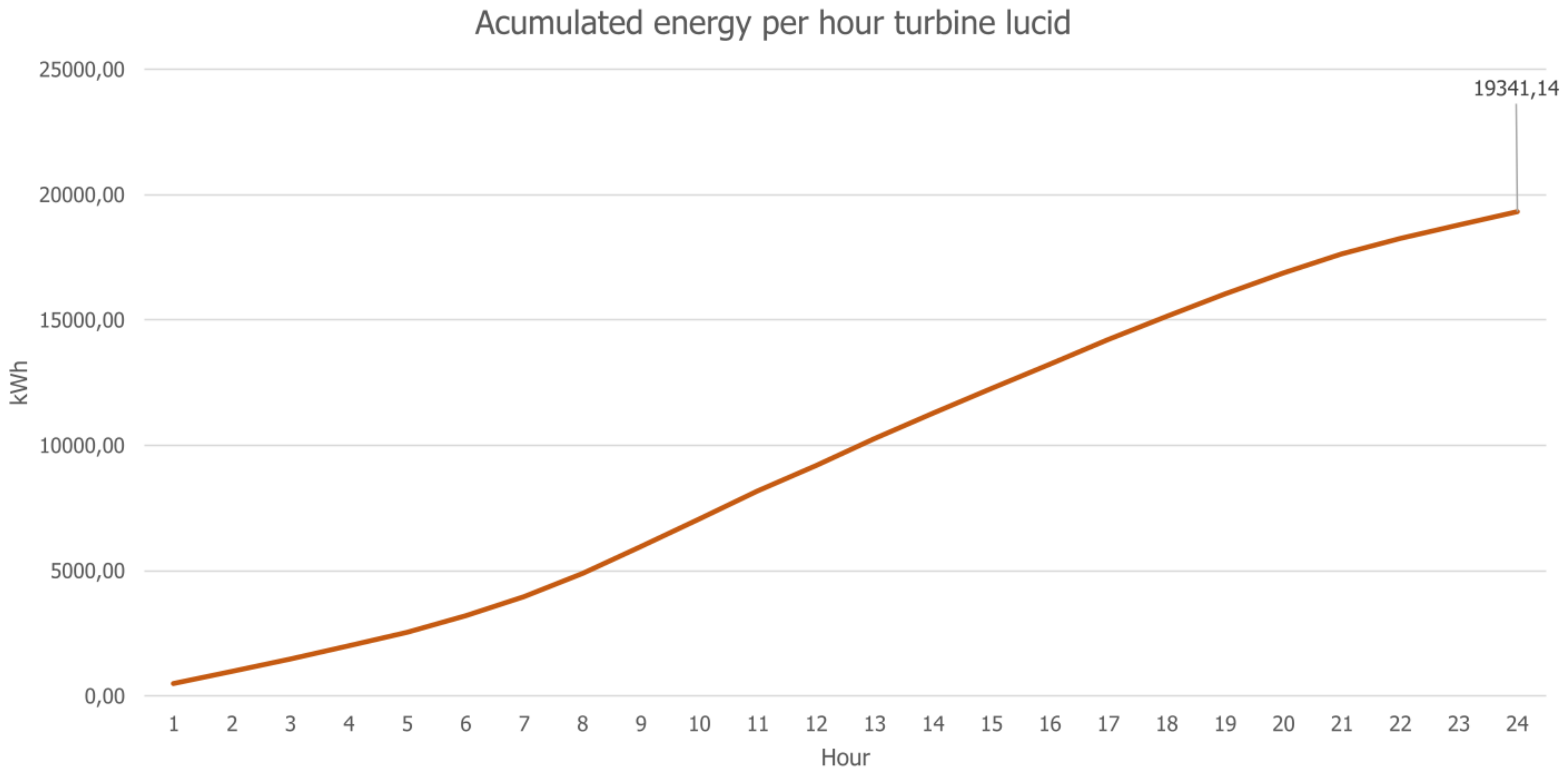
Sale price of energy of turbine ideal

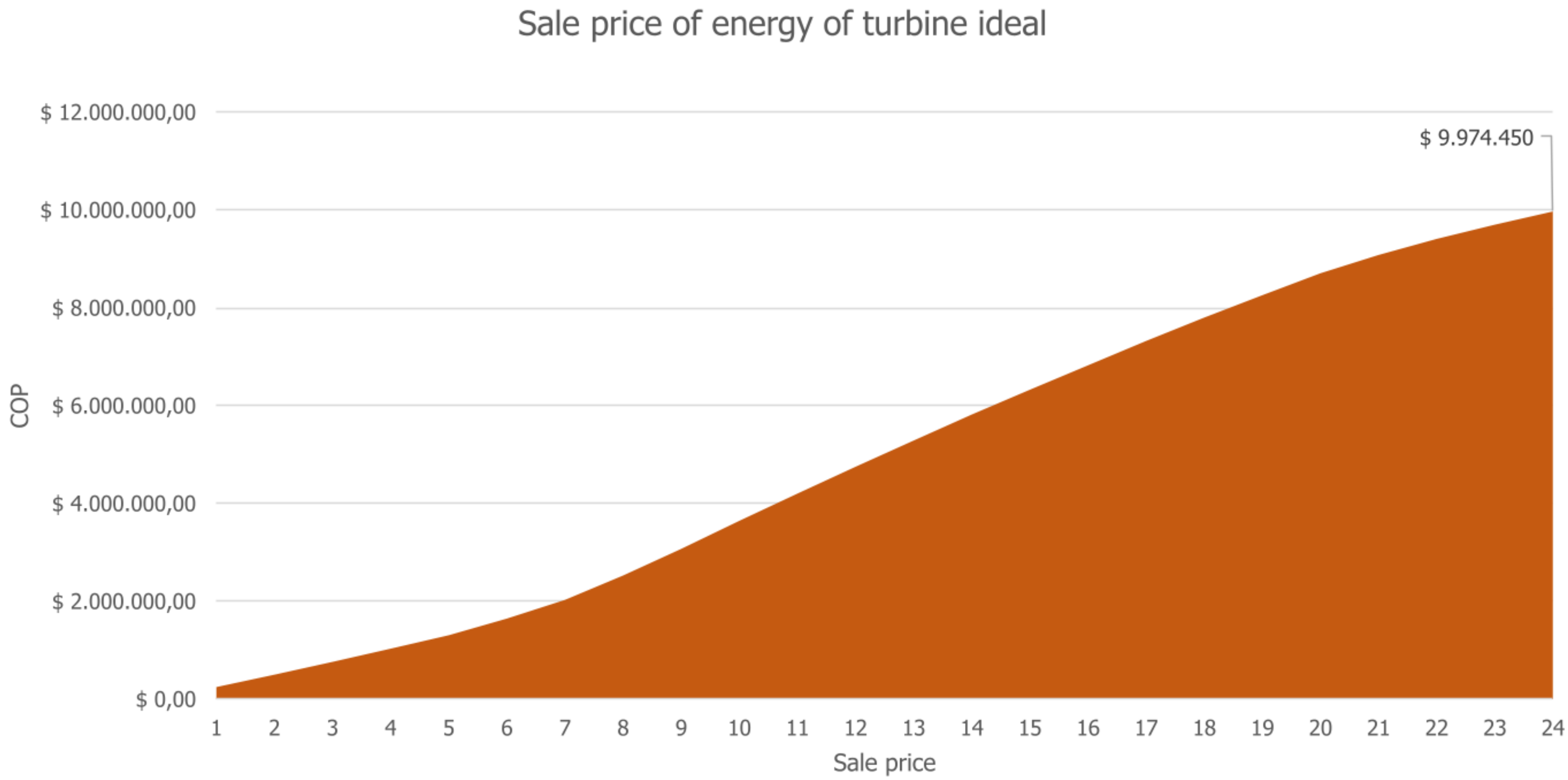


IV. Results



Hydropower generation Lucidpipe
100
90
80
70
60
50
40
30
20
10
0
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
10-11
11-12
12-13
13-14
14-15
15-16
16-17
17-18
18-19
19-20
20-21
21-22
22-23
23-24
T1
T3
T5
T9
T10
T11
T18
T19
T20
T21
T24
T34
T35


Acumulated energy per hour turbine lucid
19341,14
25000,00
20000,00
15000,00
10000,00
5000,00
0,00
kWh
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hour


Sale price of energy of turbine ideal
$ 12.000.000,00
$ 10.000.000,00
$ 8.000.000,00
$ 6.000.000,00
$ 4.000.000,00
$ 2.000.000,00
$ 0,00
COP
$ 9.974.450
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Sale price

III. Conclusions

The generation is directly affected by two parameters: the length of the sections and ; and the flow that each pipe transports.

Currently there are not many internal turbines that control the pressure.

The city has a great potential (119.276,07 kWh-day) due to its mountainous topography.

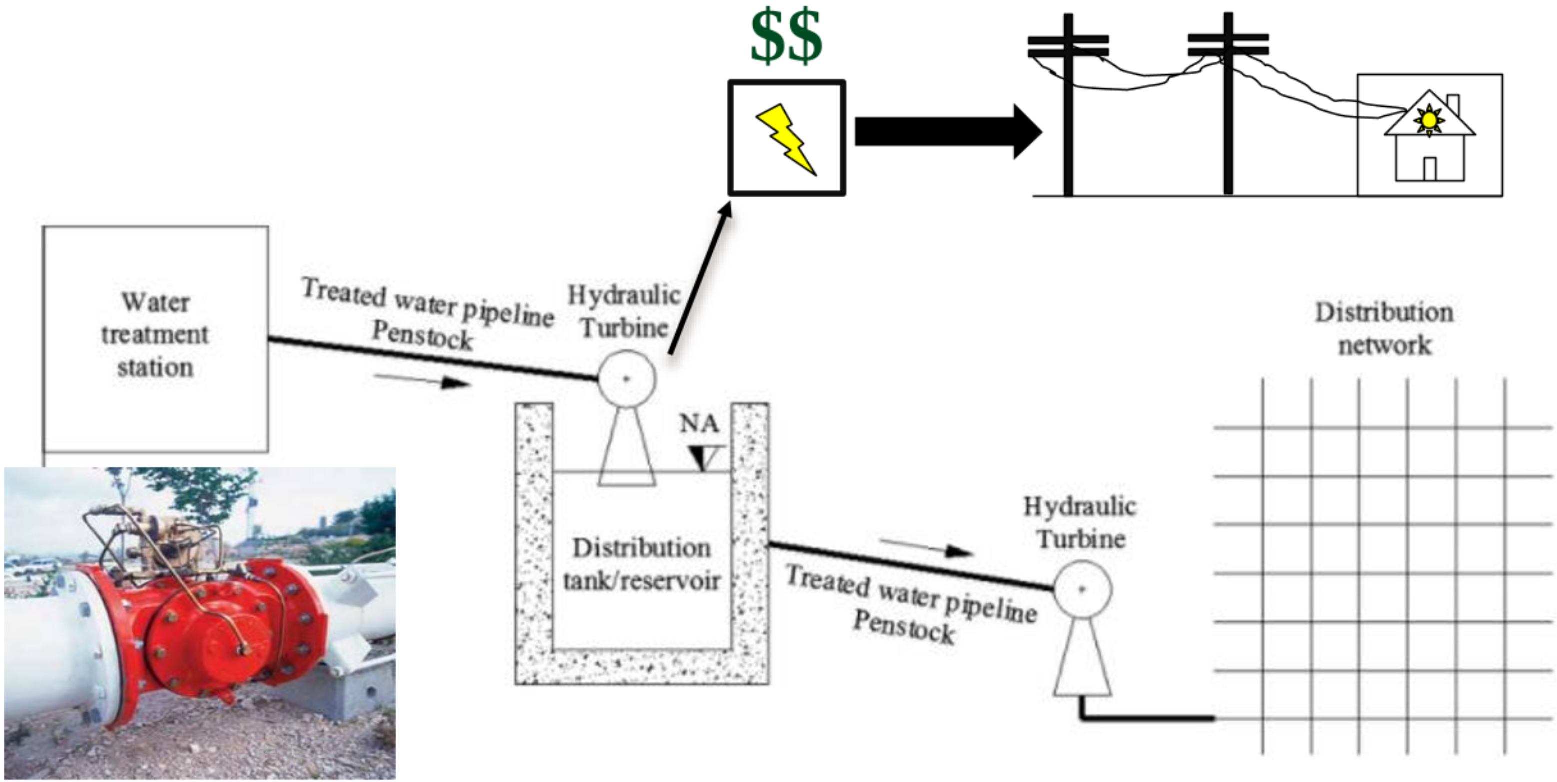
For more accurate calculations, more precise real-time data are needed.

The current technologies do not allow to exploit all the potential that comes with harvesting energy from the network.

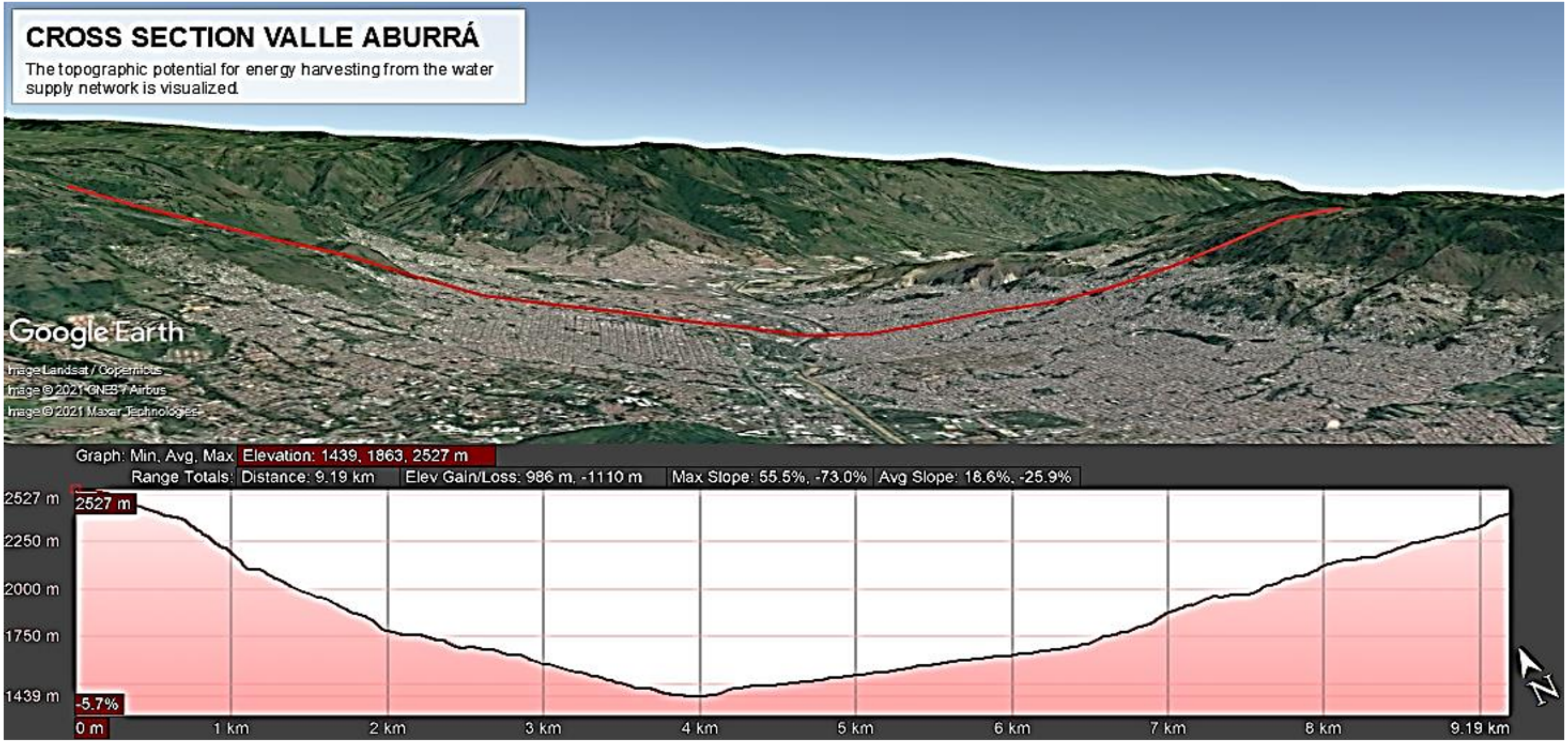
This generation system could provide a percentage of electrical energy for the operation of the aqueduct itself, making these networks more resilient systems.

VI. Questions

General idea

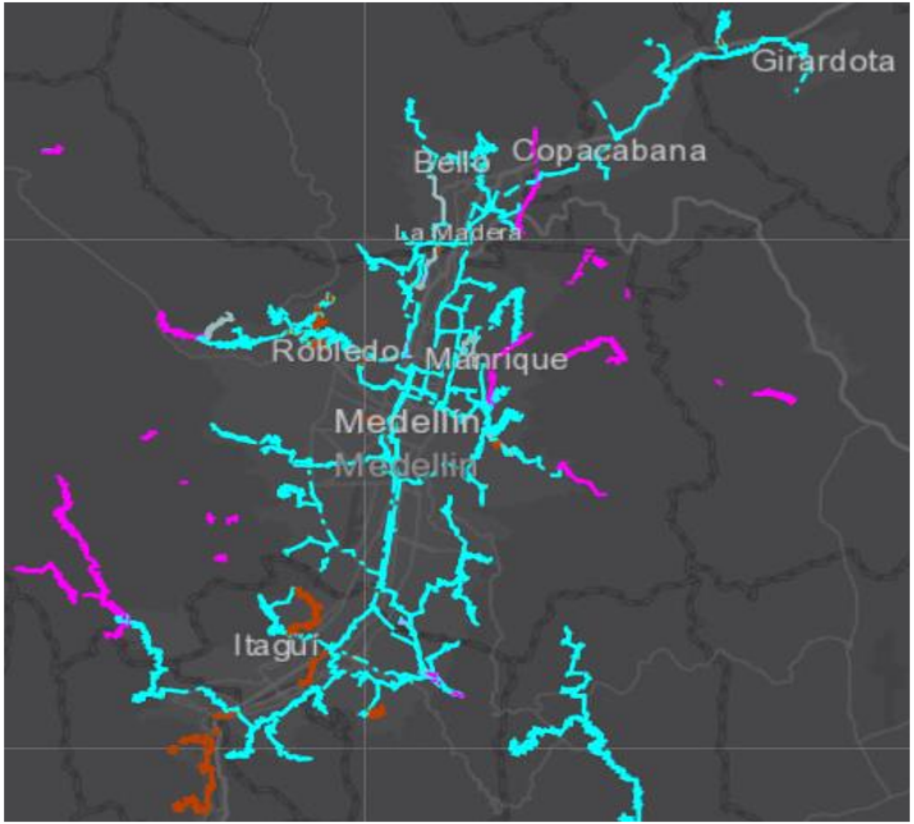


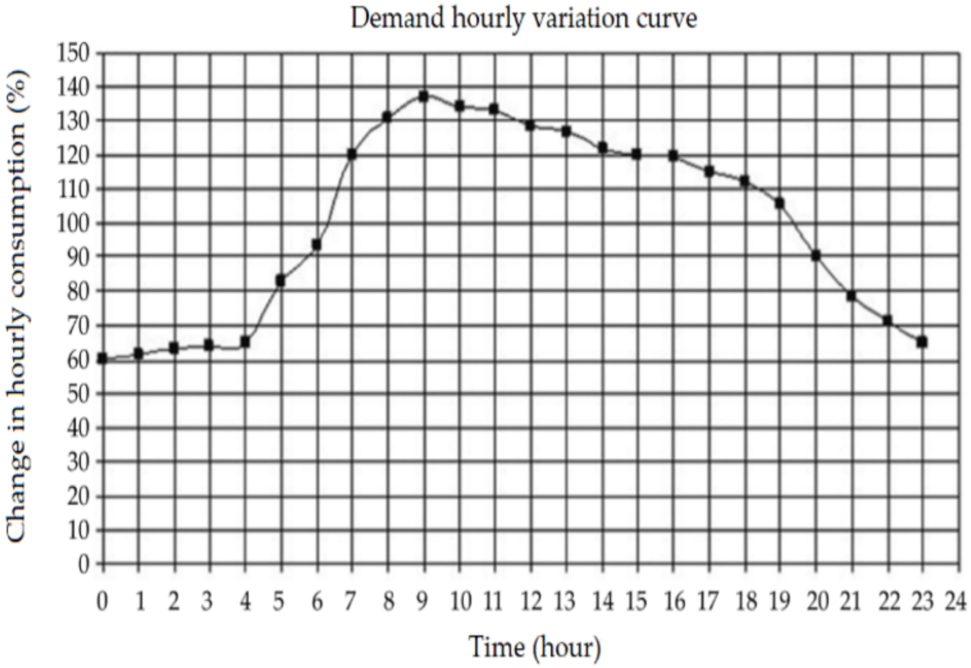
Location


CROSS SECTION VALLE ABURRÁ
The topographic potential for energy harvesting from the water supply network is visualized.
Google Earth
Image Landsat / Copernicus
Image © 2021 CNES / Airbus
Image © 2021 Maxar Technologies
Graph: Min, Avg, Max Elevation: 1439, 1863, 2527 m
Range Totals: Distance: 9.19 km Elev Gain/Loss: 986 m, -1110 m Max Slope: 55.5%, -73.0% Avg Slope: 16.6%, -25.9%
2527 m
2250 m
2000 m
1750 m
1439 m
2527 m
-5.7%
0 m
1 km
2 km
3 km
4 km
5 km
6 km
7 km
8 km
9.19 km
N

Tanque Altos de Niquía(1609m)
Tanque Niquía(1494m)
1557 m
285 m
-6.9%
NIQUIA
236 m
1970
© 2021 Google
Image © 2021 Maxar Technologies
Google Earth
lat 6.348981° lon -75.548675° elev 1557 m eye alt 2.34 km
Graph: Min, Avg, Max Elevation: 1556, 1576, 1610 m
Range Totals: Distance: 280 m Elev Gain/Loss: 7.56 m, -60 m Max Slope: 10.2%, -56.4% Avg Slope: 3.3%, -23.1%
1610 m
1575 m
1550 m
1525 m
1492 m
1557 m
-6.9%
75 m
150 m
225 m
285 m
375 m
450 m
525 m
600 m
699 m

Network of Aqueduct





Case of study

Portland – LUCID PIPE

1. Identification of key points