

Plan de Expansión del Sistema  
Interconectado Nacional  
2015 – 2029

Tomo I  
Estudios Básicos

**ANEXO I – 2**

**Bondad de Ajustes  
&  
Regresiones Sectoriales**

ETESA - EMPRESA DE TRANSMISIÓN ELÉCTRICA S.A.  
 PRONÓSTICO DE LA DEMANDA DE ELÉCTRICA DE PANAMÁ  
 MODELOS DE REGRESIÓN LINEAL MÚLTIPLE

### REGRESIÓN LINEAL MÚLTIPLE PARA EL SECTOR COMERCIAL

$$GWHCOM(T) = 1.0143 \times GWHCOM(T-1) + 0.0230 \times PIBCOM(T) - 8.1346 \times PRETOT(T) + 109.4050$$

| INTERVALO DE TIEMPO |      |      |  |
|---------------------|------|------|--|
| PASADO              | 1971 | 2014 |  |
| FUTURO              | 2015 | 2029 |  |

| ESTADÍSTICOS DE REGRESIÓN                       |           |
|---|-----------|
| Coef. de correlación (R <sup>2</sup> )          | 0.9968    |
| Coef. ajustado (R <sup>2</sup> <sub>adj</sub> ) | 0.9965    |
| Durbin-Watson (d)                               | 1.8139    |
| Jarque Bera (J)                                 | 2.8182    |
| Log likelihood                                  | -236.9574 |
| Schwarz   | 11.1148   |

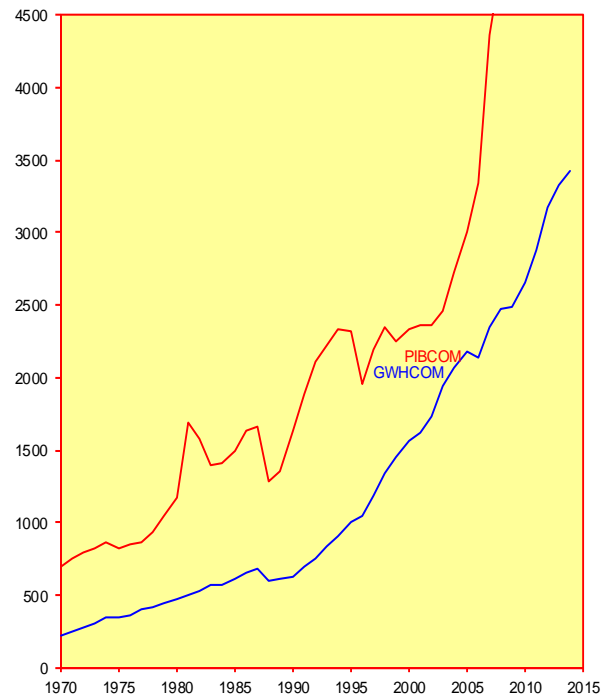
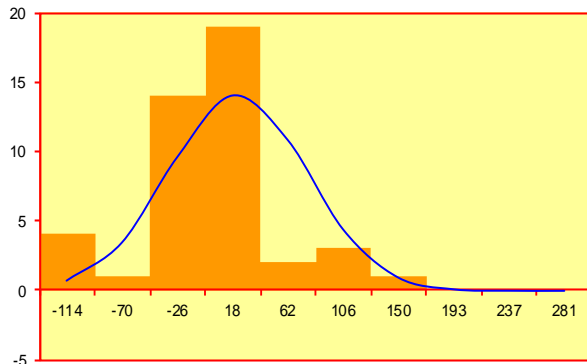
| VALORES CRÍTICOS                            |        |
|---|--------|
| Nivel de confianza (1-α)                    | 75%    |
| Límite inferior (d <sub>L</sub> )           | 1.3380 |
| Límite superior (d <sub>U</sub> )           | 1.6590 |
| t-student (t <sub>α/2</sub> )               | 1.1673 |
| Fisher (F <sub>α</sub> )                    | 1.4239 |
| Chi-cuadrado (χ <sup>2</sup> <sub>α</sub> ) | 2.7726 |

| TAMAÑO DE LA MUESTRA |    |
|----------------------|----|
| Variabes (m)         | 4  |
| Observaciones (n)    | 44 |

| PRUEBA ESTADÍSTICA INDIVIDUAL  |        |           |         |         |               |
|--|--------|-----------|---------|---------|---------------|
| H <sub>0</sub> : β <sub>j</sub> = 0 vs H <sub>1</sub> : β <sub>j</sub> ≠ 0 |        |           |         |         |               |
| VARIABLE   | GRADOS | ESTIMADOR | ERROR   | t       | P(tα/2 >  t ) |
| CTE  | 40     | 109.4050  | 59.7885 | 1.8299  | 7.5E-02       |
| PIBCOM   | 40     | 0.0230    | 0.0158  | 1.4510  | 1.5E-01       |
| PRETOT   | 40     | -8.1346   | 4.4714  | -18.193 | 7.6E-02       |
| DESFASE  | 40     | 1.0143    | 0.0314  | 32.3067 | 2.8E-30       |

| PRUEBA ESTADÍSTICA COLECTIVA   |        |          |          |      |                       |
|--|--------|----------|----------|------|-----------------------|
| H <sub>0</sub> : β <sub>1</sub> = ... = β <sub>j</sub> = ... = β <sub>m</sub> = 0 vs H <sub>1</sub> : β <sub>1</sub> ≠ ... ≠ β <sub>j</sub> ≠ ... ≠ β <sub>m</sub> ≠ 0 |        |          |          |      |                       |
| VARIABLE   | GRADOS | SUMA     | PROMEDIO | F    | P(F <sub>α</sub> > F) |
| STC  | 43     | 38097563 | 885990   | 4128 | 7.3E-50               |
| SEC  | 3      | 37974911 | 12658304 |      |                       |
| SRC  | 40     | 122652   | 3066     |      |                       |

| HISTOGRAMA DE RESIDUOS |          |           |            |        |           |
|------------------------|----------|-----------|------------|--------|-----------|
| MÍNIMO                 | MÁXIMO   | PROMEDIO  | FRECUENCIA | NORMAL | ACUMULADO |
| -135.8950              | -91.9829 | -113.9390 | 4          | 1      | 2%        |
| -91.9829               | -48.0707 | -70.0268  | 1          | 3      | 9%        |
| -48.0707               | -4.1586  | -26.1146  | 14         | 10     | 31%       |
| -4.1586                | 39.7536  | 17.7975   | 19         | 14     | 63%       |
| 39.7536                | 83.6658  | 61.7097   | 2          | 11     | 88%       |
| 83.6658                | 127.5779 | 105.6218  | 3          | 4      | 98%       |
| 127.5779               | 171.4901 | 149.5340  | 1          | 1      | 100%      |
| 171.4901               | 215.4022 | 193.4462  | 0          | 0      | 100%      |
| 215.4022               | 259.3144 | 237.3583  | 0          | 0      | 100%      |
| 259.3144               | 303.2265 | 281.2705  | 0          | 0      | 100%      |



### REGRESIÓN LINEAL MÚLTIPLE PARA EL SECTOR RESIDENCIAL

$$GWHRES(T) = 0.9970 \times GWHRES(T-1) + 0.0863 \times POBURB(T) - 0.2031 \times POBRUR(T) + 137.3794$$

| INTERVALO DE TIEMPO |      |      |
|---------------------|------|------|
| PASADO              | 1971 | 2014 |
| FUTURO              | 2015 | 2029 |

| TAMAÑO DE LA MUESTRA |    |
|----------------------|----|
| VARIABLES (m)        | 4  |
| OBSERVACIONES (n)    | 44 |

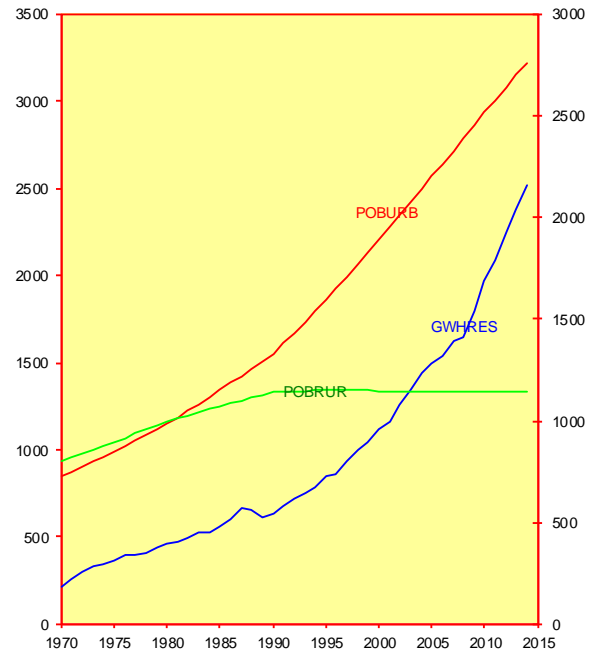
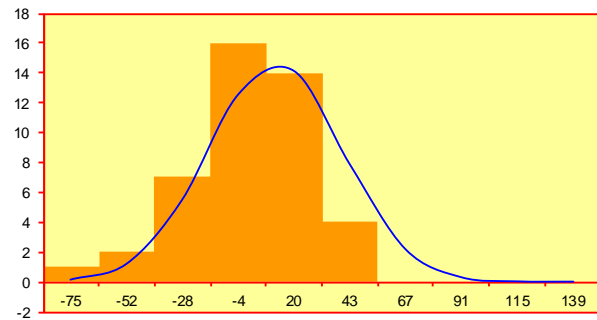
| ESTADÍSTICOS DE REGRESIÓN                       |           |
|---|-----------|
| Coef. de correlación (R <sup>2</sup> )          | 0.9980    |
| Coef. ajustado (R <sup>2</sup> <sub>ADJ</sub> ) | 0.9979    |
| Durbin-Watson (d)                               | 2.0313    |
| Jarque Bera (χ)                                 | 8.6239    |
| Log likelihood                                  | -207.6086 |
| Schwarz   | 9.7808    |

| VALORES CRÍTICOS                            |        |
|---|--------|
| Nivel de confianza (1-α)                    | 91%    |
| Límite inferior (d <sub>L</sub> )           | 1.3380 |
| Límite superior (d <sub>U</sub> )           | 1.6590 |
| t-student (t <sub>α/2</sub> )               | 1.7375 |
| Fisher (F <sub>α</sub> )                    | 2.3186 |
| Chi-cuadrado (χ <sup>2</sup> <sub>α</sub> ) | 4.8159 |

| PRUEBA ESTADÍSTICA INDIVIDUAL  |        |           |         |         |                           |
|--|--------|-----------|---------|---------|---------------------------|
| H <sub>0</sub> : β <sub>j</sub> = 0 vs H <sub>t</sub> : β <sub>j</sub> ≠ 0 |        |           |         |         |                           |
| VARIABLE   | GRADOS | ESTIMADOR | ERROR   | t       | P(t <sub>α/2</sub> >  t ) |
| CTE  | 40     | 137.3794  | 61.7875 | 2.2234  | 3.2E-02                   |
| POBURB   | 40     | 0.0863    | 0.0496  | 1.7389  | 9.0E-02                   |
| POBRUR   | 40     | -0.2031   | 0.0833  | -2.4393 | 1.9E-02                   |
| DESFASE  | 40     | 0.9970    | 0.0457  | 21.8049 | 8.2E-24                   |

| PRUEBA ESTADÍSTICA COLECTIVA   |        |          |          |      |                       |
|--|--------|----------|----------|------|-----------------------|
| H <sub>0</sub> : β <sub>1</sub> = ... = β <sub>j</sub> = ... = β <sub>m</sub> = 0 vs H <sub>t</sub> : β <sub>1</sub> ≠ ... ≠ β <sub>j</sub> ≠ ... ≠ β <sub>m</sub> ≠ 0 |        |          |          |      |                       |
| VARIABLE   | GRADOS | SUMA     | PROMEDIO | F    | P(F <sub>α</sub> > F) |
| STC  | 43     | 16444519 | 382431   | 6773 | 3.8E-54               |
| SEC  | 3      | 16412211 | 5470737  |      |                       |
| SRC  | 40     | 32308    | 808      |      |                       |

| HISTOGRAMA DE RESIDUOS |          |          |            |        |           |
|------------------------|----------|----------|------------|--------|-----------|
| MÍNIMO                 | MÁXIMO   | PROMEDIO | FRECUENCIA | NORMAL | ACUMULADO |
| -87.1512               | -63.3972 | -75.2742 | 1          | 0      | 0%        |
| -63.3972               | -39.6433 | -51.5203 | 2          | 1      | 3%        |
| -39.6433               | -15.8894 | -27.7663 | 7          | 6      | 16%       |
| -15.8894               | 7.8646   | -4.0124  | 16         | 13     | 44%       |
| 7.8646                 | 31.6185  | 19.7416  | 14         | 14     | 76%       |
| 31.6185                | 55.3725  | 43.4955  | 4          | 8      | 94%       |
| 55.3725                | 79.1264  | 67.2495  | 0          | 2      | 99%       |
| 79.1264                | 102.8804 | 91.0034  | 0          | 0      | 100%      |
| 102.8804               | 126.6343 | 114.7574 | 0          | 0      | 100%      |
| 126.6343               | 150.3883 | 138.5113 | 0          | 0      | 100%      |



### REGRESIÓN LINEAL MÚLTIPLE PARA EL SECTOR OFICIAL

$$GWHOFI(T) = 0.9529 \times GWHOFI(T-1) + 0.0016 \times PIBREA(T-1) - 16.7833$$

| INTERVALO DE TIEMPO |      |      |
|---------------------|------|------|
| PASADO              | 1971 | 2014 |
| FUTURO              | 2015 | 2029 |

| TAMAÑO DE LA MUESTRA |    |
|----------------------|----|
| VARIABLES (m)        | 3  |
| OBSERVACIONES (n)    | 44 |

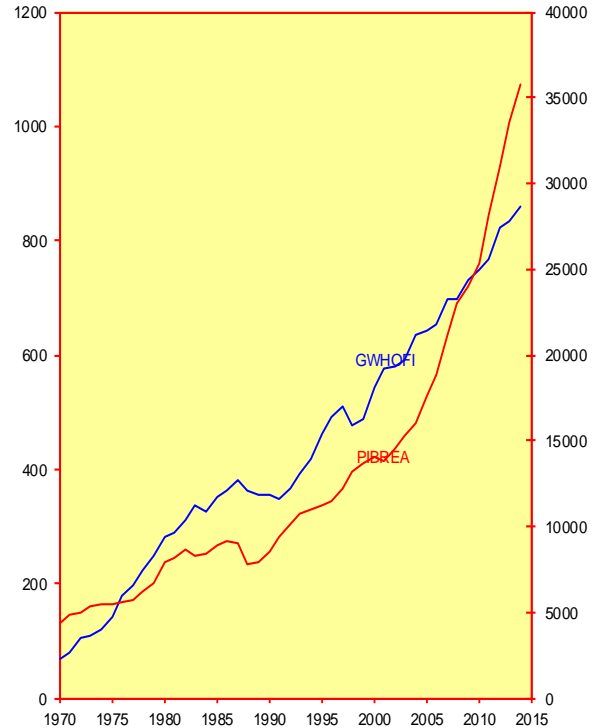
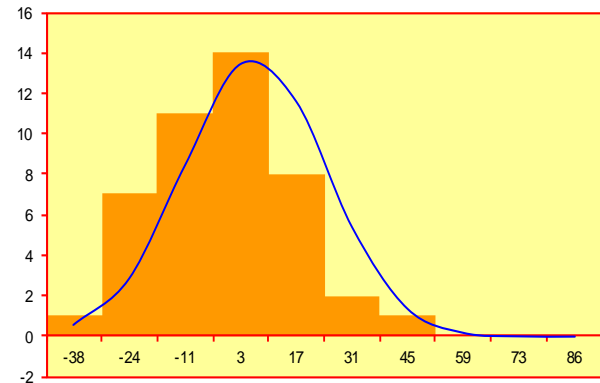
| ESTADÍSTICOS DE REGRESIÓN                       |           |
|---|-----------|
| Coef. de correlación (R <sup>2</sup> )          | 0.9937    |
| Coef. ajustado (R <sup>2</sup> <sub>ADJ</sub> ) | 0.9933    |
| Durbin-Watson (d)                               | 1.9481    |
| Jarque Bera (χ)                                 | 0.0296    |
| Log likelihood                                  | -187.1043 |
| Schwarz   | 8.7628    |

| VALORES CRÍTICOS                            |        |
|---|--------|
| Nivel de confianza (1-α)                    | 90%    |
| Límite inferior (d <sub>L</sub> )           | 1.3910 |
| Límite superior (d <sub>U</sub> )           | 1.6000 |
| t-student (t <sub>α/2</sub> )               | 1.6829 |
| Fisher (F <sub>α</sub> )                    | 2.4369 |
| Chi-cuadrado (χ <sup>2</sup> <sub>α</sub> ) | 4.6052 |

| PRUEBA ESTADÍSTICA INDIVIDUAL  |        |           |        |         |                           |
|--|--------|-----------|--------|---------|---------------------------|
| H <sub>0</sub> : β <sub>j</sub> = 0 vs H <sub>1</sub> : β <sub>j</sub> ≠ 0 |        |           |        |         |                           |
| VARIABLE   | GRADOS | ESTIMADOR | ERROR  | t       | P(t <sub>α/2</sub> >  t ) |
| CTE  | 41     | 16.7833   | 6.1711 | 2.7197  | 9.5E-03                   |
| PIBREA   | 41     | 0.0016    | 0.0009 | 1.7554  | 8.7E-02                   |
| DESFASE  | 41     | 0.9529    | 0.0345 | 27.5963 | 4.2E-28                   |

| PRUEBA ESTADÍSTICA COLECTIVA   |        |         |          |       |                       |
|--|--------|---------|----------|-------|-----------------------|
| H <sub>0</sub> : β <sub>1</sub> = ... = β <sub>j</sub> = ... = β <sub>m</sub> = 0 vs H <sub>1</sub> : β <sub>1</sub> ≠ ... ≠ β <sub>j</sub> ≠ ... ≠ β <sub>m</sub> ≠ 0 |        |         |          |       |                       |
| VARIABLE   | GRADOS | SUMA    | PROMEDIO | F     | P(F <sub>α</sub> > F) |
| STC  | 43     | 2005857 | 46648    | 32.12 | 8.8E-46               |
| SEC  | 2      | 1993135 | 996568   |       |                       |
| SRC  | 41     | 12722   | 310      |       |                       |

| HISTOGRAMA DE RESIDUOS |          |          |            |        |           |
|------------------------|----------|----------|------------|--------|-----------|
| MÍNIMO                 | MÁXIMO   | PROMEDIO | FRECUENCIA | NORMAL | ACUMULADO |
| -45.1634               | -31.3070 | -38.2352 | 1          | 1      | 1%        |
| -31.3070               | -17.4507 | -24.3789 | 7          | 3      | 8%        |
| -17.4507               | -3.5943  | -10.5225 | 11         | 8      | 27%       |
| -3.5943                | 10.2621  | 3.3339   | 14         | 13     | 58%       |
| 10.2621                | 24.1185  | 17.1903  | 8          | 12     | 84%       |
| 24.1185                | 37.9748  | 31.0467  | 2          | 5      | 96%       |
| 37.9748                | 51.8312  | 44.9030  | 1          | 1      | 100%      |
| 51.8312                | 65.6876  | 58.7594  | 0          | 0      | 100%      |
| 65.6876                | 79.5440  | 72.6158  | 0          | 0      | 100%      |
| 79.5440                | 93.4003  | 86.4722  | 0          | 0      | 100%      |



### REGRESIÓN LINEAL MÚLTIPLE PARA EL SECTOR INDUSTRIAL

$$GWHIND(T) = 0.6279 \times GWHIND(T-1) + 0.1643 \times PIBMAN(T) - 0.0020 \times PIBSUB(T) - 49.2238$$

| INTERVALO DE TIEMPO |      |      |
|---------------------|------|------|
| PASADO              | 1971 | 2014 |
| FUTURO              | 2015 | 2029 |

| TAMAÑO DE LA MUESTRA |    |
|----------------------|----|
| Variables (m)        | 4  |
| Observaciones (n)    | 44 |

| ESTADÍSTICOS DE REGRESIÓN                       |           |
|---|-----------|
| Coef. de correlación (R <sup>2</sup> )          | 0.9693    |
| Coef. ajustado (R <sup>2</sup> <sub>adj</sub> ) | 0.9670    |
| Durbin-Watson (d)                               | 1.5643    |
| Jarque Bera (γ)                                 | 2.16925   |
| Log likelihood                                  | -213.7129 |
| Schwarz   | 10.0582   |

| VALORES CRÍTICOS                            |        |
|---|--------|
| Nivel de confianza (1-α)                    | 70%    |
| Límite inferior (d <sub>L</sub> )           | 1.3380 |
| Límite superior (d <sub>U</sub> )           | 1.6590 |
| t-student (t <sub>α/2</sub> )               | 10.500 |
| Fisher (F <sub>α</sub> )                    | 1.2631 |
| Chi-cuadrado (χ <sup>2</sup> <sub>α</sub> ) | 2.4079 |

| PRUEBA ESTADÍSTICA INDIVIDUAL  |        |           |         |         |                           |
|--|--------|-----------|---------|---------|---------------------------|
| H <sub>0</sub> : β <sub>j</sub> = 0 vs H <sub>1</sub> : β <sub>j</sub> ≠ 0 |        |           |         |         |                           |
| VARIABLE   | GRADOS | ESTIMADOR | ERROR   | t       | P(t <sub>α/2</sub> >  t ) |
| CTE  | 40     | -49.2238  | 23.3059 | -2.1121 | 4.1E-02                   |
| PIBMAN   | 40     | 0.1643    | 0.0487  | 3.3703  | 1.7E-03                   |
| PIBSUB   | 40     | 0.0020    | 0.0018  | 1.0692  | 2.9E-01                   |
| DESFASE  | 40     | 0.6279    | 0.0988  | 6.3538  | 1.5E-07                   |

| PRUEBA ESTADÍSTICA COLECTIVA   |        |         |          |     |                       |
|--|--------|---------|----------|-----|-----------------------|
| H <sub>0</sub> : β <sub>1</sub> = ... = β <sub>j</sub> = ... = β <sub>m</sub> = 0 vs H <sub>1</sub> : β <sub>1</sub> ≠ ... ≠ β <sub>j</sub> ≠ ... ≠ β <sub>m</sub> ≠ 0 |        |         |          |     |                       |
| VARIABLE   | GRADOS | SUMA    | PROMEDIO | F   | P(F <sub>α</sub> > F) |
| STC  | 43     | 1389580 | 32316    | 421 | 2.8E-30               |
| SEC  | 3      | 1346940 | 448980   |     |                       |
| SRC  | 40     | 42640   | 1066     |     |                       |

| HISTOGRAMA DE RESIDUOS |          |          |            |        |           |
|------------------------|----------|----------|------------|--------|-----------|
| MÍNIMO                 | MÁXIMO   | PROMEDIO | FRECUENCIA | NORMAL | ACUMULADO |
| -113.7726              | -79.9195 | -96.8461 | 1          | 0      | 0%        |
| -79.9195               | -46.0665 | -62.9930 | 1          | 1      | 2%        |
| -46.0665               | -12.2135 | -29.1400 | 10         | 7      | 18%       |
| -12.2135               | 21.6395  | 4.7130   | 22         | 17     | 56%       |
| 21.6395                | 55.4926  | 38.5660  | 9          | 15     | 89%       |
| 55.4926                | 89.3456  | 72.4191  | 1          | 4      | 99%       |
| 89.3456                | 123.1986 | 106.2721 | 0          | 0      | 100%      |
| 123.1986               | 157.0516 | 140.1251 | 0          | 0      | 100%      |
| 157.0516               | 190.9047 | 173.9781 | 0          | 0      | 100%      |
| 190.9047               | 224.7577 | 207.8312 | 0          | 0      | 100%      |

