

# Energy-efficiency vs. resilience

## Code for optimization procedures and simulations

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To reproduce the steps of the algorithm presented in the paper, save attached files to a common directory and provide required tools.

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## SOFTWARE REQUIREMENTS

- CPLEX (including OPL Interpreter): <http://www-01.ibm.com/software/commerce/optimization/cplex-optimizer/>
- MATLAB (including MATLAB Compiler): <http://www.mathworks.com/products/matlab/>

## RISK-OPTIMIZATION-CAPACITY-POLAND.DAT

This CPLEX data presents data suitable for the Poland network and the fine-grained risk optimization, when reserved capacity is a basis for the budget calculation.

```

1 //*****/
2 // OPL 12.6.0.0 Data
3 // Author: cholda
4 // Creation Date: 20 July 2014 at 15:03:30
5 //*****/
6
7 Capacity_baseline = 26243;
8
9 Risk_baseline = 1255.857;
10
11 coefficient_capacity = 0.001;
12
13 //coefficient_capacity = 0.01;
14
15 //coefficient_capacity = 0.1;
16
17 coefficient_risk = 0.02;
18
19 //coefficient_risk = 0.2;
20
21 //coefficient_risk = 2;
22
23 RecoveryMethod = {NoRecovery,
24                   DedicatedPathProtection,
25                   DedicatedLinkProtection,
26                   SharedBackupPathProtection,
27                   SharedBackupLinkProtection};
28
29 Nodes = {Gdansk,
30          Bydgoszcz,
31          Kolobrzeg,
32          Katowice,
33          Krakow,
34          Bialystok,
35          Lodz,
36          Poznan,
37          Rzeszow,
38          Szczecin,
39          Warsaw,
40          Wroclaw};
41
42 Arcs = {<Gdansk,Warsaw>, <Gdansk,Kolobrzeg>,
43         <Bydgoszcz,Kolobrzeg>, <Bydgoszcz,Poznan>,
44         <Bydgoszcz,Warsaw>, <Kolobrzeg,Szczecin>,
45         <Katowice,Krakow>, <Katowice,Lodz>,
46         <Katowice,Wroclaw>, <Krakow,Rzeszow>,
47         <Krakow,Warsaw>, <Bialystok,Rzeszow>,
48         <Bialystok,Warsaw>, <Lodz,Warsaw>,
49         <Lodz,Wroclaw>, <Poznan,Szczecin>,
50         <Poznan,Wroclaw>, <Gdansk,Bialystok>};
51
52 Demands = {<Gdansk,Bydgoszcz>, <Gdansk,Kolobrzeg>,
53            <Gdansk,Katowice>, <Gdansk,Krakow>,
54            <Gdansk,Bialystok>, <Gdansk,Lodz>,
55            <Gdansk,Poznan>, <Gdansk,Rzeszow>,
56            <Gdansk,Szczecin>, <Gdansk,Warsaw>,
57            <Gdansk,Wroclaw>, <Bydgoszcz,Kolobrzeg>,
58            <Bydgoszcz,Katowice>, <Bydgoszcz,Krakow>,
59            <Bydgoszcz,Bialystok>, <Bydgoszcz,Lodz>,
60            <Bydgoszcz,Poznan>, <Bydgoszcz,Rzeszow>,
61            <Bydgoszcz,Szczecin>, <Bydgoszcz,Warsaw>,
62            <Bydgoszcz,Wroclaw>, <Kolobrzeg,Katowice>,
63            <Kolobrzeg,Krakow>, <Kolobrzeg,Bialystok>,
64            <Kolobrzeg,Lodz>, <Kolobrzeg,Poznan>,
65            <Kolobrzeg,Rzeszow>, <Kolobrzeg,Szczecin>,

```

```

66 <Kolobrzeg,Warsaw>, <Kolobrzeg,Wroclaw>,
67 <Katowice,Krakow>, <Katowice,Bialystok>,
68 <Katowice,Lodz>, <Katowice,Poznan>,
69 <Katowice,Rzeszow>, <Katowice,Szczecin>,
70 <Katowice,Warsaw>, <Katowice,Wroclaw>,
71 <Krakow,Bialystok>, <Krakow,Lodz>,
72 <Krakow,Poznan>, <Krakow,Rzeszow>,
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80 <Poznan,Rzeszow>, <Poznan,Szczecin>,
81 <Poznan,Warsaw>, <Poznan,Wroclaw>,
82 <Rzeszow,Szczecin>, <Rzeszow,Warsaw>,
83 <Rzeszow,Wroclaw>, <Szczecin,Warsaw>,
84 <Szczecin,Wroclaw>, <Warsaw,Wroclaw>;
85
86
87
88 risk = [[ 1.913620e+01 2.592533e+01 2.130716e+01 1.726739e+01 1.670131e+01 1.512806e+01 ↵
    ↵2.384903e+01 2.403061e+01 3.166000e+01 9.448962e+00 2.856705e+01 6.805706e+00 2.156162e↵
    ↵+01 1.752198e+01 1.695603e+01 1.538298e+01 4.720883e+00 2.428500e+01 1.255413e+01 ↵
    ↵9.704139e+00 9.446951e+00 2.835007e+01 2.431252e+01 2.374714e+01 2.217613e+01 1.152361e↵
    ↵+01 3.106967e+01 1.934999e+01 1.650153e+01 1.624671e+01 4.045199e+00 1.912326e+01 ↵
    ↵1.755013e+01 2.627371e+01 1.082150e+01 3.408425e+01 1.187184e+01 3.099103e+01 1.508278e↵
    ↵+01 1.350910e+01 2.223554e+01 6.778372e+00 3.004848e+01 7.829089e+00 2.695420e+01 ↵
    ↵1.294224e+01 2.166982e+01 2.184797e+01 2.948371e+01 7.261743e+00 2.638886e+01 2.009731e↵
    ↵+01 2.027639e+01 2.791426e+01 5.684874e+00 2.481696e+01 2.899571e+01 7.836561e+00 ↵
    ↵1.442099e+01 4.728076e+00 3.680208e+01 1.460061e+01 3.371153e+01 2.224278e+01 1.256111e↵
    ↵+01 1.914300e+01 ]
89 [ 3.820196e-02 2.893414e-02 8.539864e-02 8.131518e-02 3.606743e-02 5.621322e-02 1.240463e-01 ↵
    ↵8.677514e-02 5.476483e-02 3.207156e-02 6.366588e-02 2.306862e-02 3.476745e-02 3.522676e↵
    ↵-02 1.072725e-01 2.980228e-02 1.176616e-02 1.249570e-01 1.753146e-02 2.628179e-02 ↵
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    ↵-02 3.397683e-02 2.152877e-02 7.995257e-02 1.145611e-02 2.406160e-02 7.598927e-02 ↵
    ↵1.172232e-01 2.991461e-02 1.917732e-01 2.275016e-02 1.086507e-01 2.861877e-02 1.087004e↵
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    ↵1.191194e-02 2.051600e-01 3.433123e-02 1.260801e-01 7.158826e-02 5.283530e-02 2.949006e↵
    ↵-02 ]
90 [ 6.754708e-02 8.260792e-02 6.371807e-02 5.788227e-02 4.507518e-02 4.128951e-02 7.643219e-02 ↵
    ↵7.321473e-02 8.866733e-02 3.179290e-02 8.858970e-02 2.356565e-02 6.773475e-02 6.189895e↵
    ↵-02 5.850605e-02 4.529902e-02 8.887697e-03 7.724529e-02 2.113556e-02 3.580240e-02 ↵
    ↵2.106979e-02 8.284111e-02 7.700531e-02 7.360460e-02 6.040538e-02 3.245013e-02 9.235165e↵
    ↵-02 4.466899e-02 5.090876e-02 4.463033e-02 5.839752e-03 5.462655e-02 3.966706e-02 ↵
    ↵7.661986e-02 2.795085e-02 8.885499e-02 3.193235e-02 8.877354e-02 4.879075e-02 3.556550e↵
    ↵-02 7.078406e-02 2.211358e-02 8.301919e-02 2.2609655e-02 8.293925e-02 3.221151e-02 ↵
    ↵6.739116e-02 6.411309e-02 7.962630e-02 2.271489e-02 7.954867e-02 5.418413e-02 5.091184e↵
    ↵-02 6.641926e-02 9.496618e-03 6.633919e-02 8.613040e-02 1.562791e-02 4.468751e-02 ↵
    ↵1.218629e-02 9.836553e-02 4.144289e-02 9.828559e-02 5.692264e-02 2.781211e-02 5.684502e↵
    ↵-02 ]
91 [ 3.913284e-02 2.908149e-02 8.421123e-02 8.081245e-02 3.534238e-02 5.731267e-02 1.244287e-01 ↵
    ↵8.546234e-02 5.635987e-02 3.160585e-02 6.399110e-02 2.327709e-02 3.476223e-02 3.541823e↵
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    ↵1.963895e-02 9.993952e-02 9.893238e-02 7.417714e-02 7.035332e-02 1.733914e-02 1.603677e↵
    ↵-01 1.281057e-02 6.454336e-02 8.500193e-02 5.850935e-03 9.535920e-02 8.768997e-03 ↵
    ↵3.094542e-02 4.060364e-02 7.713636e-02 2.057996e-02 1.956295e-02 3.432391e-02 1.807575e↵
    ↵-02 3.449372e-02 3.927837e-02 8.087723e-02 3.277440e-02 3.668068e-02 8.196800e-02 ↵
    ↵1.600700e-01 2.998362e-02 2.002687e-01 4.722026e-02 1.357388e-01 2.983892e-02 1.080202e↵
    ↵-01 7.397062e-02 2.039999e-02 2.561216e-02 1.593584e-01 1.595132e-02 8.408835e-02 ↵
    ↵1.674682e-02 2.043588e-01 4.250670e-02 1.633847e-01 8.879265e-02 9.298969e-02 6.051575e↵
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92 [ 6.857497e-02 8.338391e-02 6.496697e-02 5.903253e-02 4.564394e-02 4.217473e-02 7.735536e-02 ↵
    ↵7.414586e-02 8.941911e-02 3.258722e-02 8.914934e-02 2.341574e-02 6.844743e-02 6.251299e↵
    ↵-02 5.865748e-02 4.564484e-02 8.783553e-03 7.763431e-02 2.086501e-02 3.605733e-02 ↵

```

```

↳2.059580e-02 8.327617e-02 7.734174e-02 7.348231e-02 6.047359e-02 3.219017e-02 9.246306e-02
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↳-02 8.200925e-02 2.403691e-02 9.818082e-02 3.718027e-02 1.022651e-01 3.220391e-02 ↵
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↳-02 ]
93 ];
94
95 capacity_usage = [[ 390 474 522 202 396 316 546 462 700 122 456 179 351 210 318 396 189 498 ↵
↳284 137 326 524 477 492 384 390 520 315 346 471 194 375 330 528 318 545 252 500 248 212 ↵
↳ 408 144 672 119 508 210 441 420 792 104 452 507 561 784 193 604 424 125 388 194 615 ↵
↳362 965 543 390 423 ]
96 [ 780 632 1218 505 594 1106 1456 770 1050 366 798 716 702 630 1272 990 945 1494 568 685 815 ↵
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↳1344 476 635 840 1176 560 1980 312 904 845 1683 1372 965 755 954 500 970 970 1353 724 ↵
↳1737 1267 1365 705 ]
97 [ 1365 1738 1914 707 1188 1106 2002 1694 2625 366 1824 716 1404 840 1113 1584 756 1992 1136 ↵
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↳2100 868 848 1632 576 2688 476 2159 735 1617 1540 2970 312 1808 2028 2244 3136 772 2567 ↵
↳1696 500 1552 970 2460 1448 4053 2172 1755 1833 ]
98 [ 4.323279e+02 4.902758e+02 5.901230e+02 2.776529e+02 4.151613e+02 3.809973e+02 6.142290e+02 ↵
↳4.924808e+02 7.365366e+02 1.464181e+02 3.812660e+02 2.281884e+02 3.881127e+02 2.604491e-02
↳+02 3.894689e+02 4.344732e+02 2.345871e+02 5.730194e+02 3.152151e+02 1.708933e+02 ↵
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↳+02 3.261058e+02 3.820411e+02 5.225518e+02 3.153213e+02 4.241820e+02 3.452103e+02 ↵
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↳+02 4.634618e+02 2.359486e+02 8.072326e+02 1.612008e+02 4.258432e+02 2.586011e+02 ↵
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↳+02 6.545180e+02 2.433294e+02 1.882856e+02 4.642019e+02 1.615606e+02 4.218988e+02 ↵
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↳+02 ]
99 [ 4.257683e+02 5.193443e+02 5.804085e+02 2.230355e+02 4.311190e+02 3.557548e+02 6.107458e+02 ↵
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↳+02 3.472784e+02 4.471601e+02 2.215683e+02 5.503906e+02 3.255885e+02 1.500286e+02 ↵
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↳+02 3.566261e+02 3.803685e+02 5.507132e+02 2.187173e+02 4.170493e+02 3.751702e+02 ↵
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↳+02 6.997467e+02 2.245140e+02 1.838776e+02 4.757201e+02 1.400697e+02 4.398791e+02 ↵
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↳+02 ]
100 ];

```