



MERCURY – Modeling the European power sector evolution: low-carbon generation technologies (renewables, CCS, nuclear), the electric infrastructure and their role in the EU leadership in climate policy

Implementation of the new modeling features (system integration, grid, storage) into the master version of WITCH

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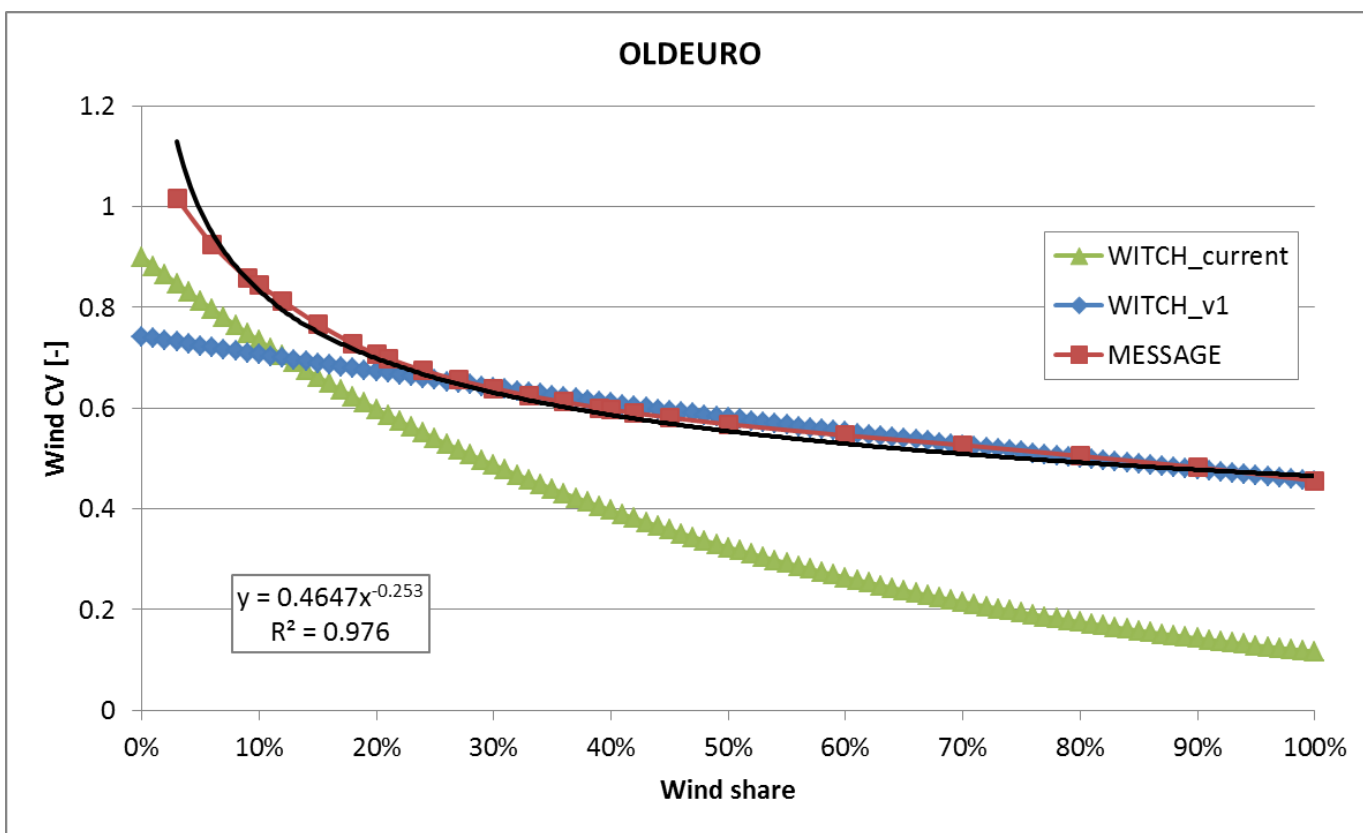
WITCH Modeling Meeting – Milan, May 22, 2018



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Changes with respect to the latest version

1. Revised the interpolation of the Capacity Values → from 6th order polynomials to power functions (with 1%-shift for “safety” reasons)



Changes with respect to the latest version

2. Gotten rid of a lot of useless parameters
3. Corrected the calculation of the Q_EN_PV_BC
4. Aligned the formulation of the full and simple version of system integration.

```
$ifthen set full_vre

Q_EN_PV.fx(solar_distance,solar_class,t,n) =

= (1 - curt_share_pv(t,n)) * Q_EN_PV_BC.l(solar_distance,solar_class,t,n);

$endif

$ifthen not set full_vre

Q_EN_PV_BC.fx(solar_distance,solar_class,t,n) = Q_EN_PV.l(solar_distance,solar_class,t,n);
Q_EN_BC.fx('elpv',t,n) = Q_EN.l('elpv',t,n);

$endif
```


Running time – CTAX (old)

Starting from the default startgdx

```
Start: 05/21/18 12:25:32
To run: tax1
sol: [Y/N][clt noopt][clt infes][tot infes]
=====
iter  sol      inv      pes      oil      nip      co2      wgt      itertime  tottime
      |      |      |      |      |      |      |      |      |
      |      |      |      |      |      |      |      |      |
      |      |      |      |      |      |      |      |      |
>tax -----
1     Y000    51.328  3.390    0.898    0.000    0.000    0.000    0:31:49  0:32:04
2     N020    20.654  2.232    1.197    0.000    0.000    0.000    0:07:13  0:39:27
3     Y000    7.070   0.632    0.970    0.000    0.000    0.000    0:05:17  0:44:56
4     Y000    3.259   0.548    0.559    0.000    0.000    0.000    0:02:12  0:47:20
5     Y000    3.007   0.495    0.171    0.000    0.000    0.000    0:02:07  0:49:39
6     Y000    2.307   0.197    0.063    0.000    0.000    0.000    0:01:41  0:51:32
7     Y000    2.207   0.065    0.055    0.000    0.000    0.000    0:01:18  0:53:01
8     Y000    0.996   0.108    0.063    0.000    0.000    0.000    0:01:16  0:54:28

59    Y000    0.000   0.000    0.005    0.000    0.000    0.000    0:00:32  1:41:11
60    Y000    0.000   0.001    0.005    0.000    0.000    0.000    0:00:33  1:41:55
61    Y000    0.008   0.002    0.005    0.000    0.000    0.000    0:00:34  1:42:39
62    Y000    0.011   0.002    0.005    0.000    0.000    0.000    0:00:35  1:43:25
63    Y000    0.011   0.002    0.005    0.000    0.000    0.000    0:00:38  1:44:14
64    Y000    0.011   0.002    0.005    0.000    0.000    0.000    0:00:36  1:45:00
65    Y000    0.011   0.002    0.005    0.000    0.000    0.000    0:00:39  1:45:49

-----
> Convergence criteria met!
=====
```

Running time – BAU (full)

Starting from the correct result

```

1 Start: 05/17/18 18:26:46
2 To run: r1
3 sol: [Y/N][clt nonopt][clt infes][tot infes]
4 =====
5 iter  sol      inv      pes      oil      nip      co2      wgt  itertime  tottime
6      |      |      |      |      |      |      |      |      |      |
7 > r1 -----
8 1    N210    0.618    0.172    0.087    0.000    0.000    0.000    0:22:49    0:23:04
9 2    N210    1.775    0.737    0.521    0.000    0.000    0.000    0:06:53    0:29:59
10 3    N210    1.784    0.711    0.123    0.000    0.000    0.000    0:04:31    0:34:32
11 4    N110    1.086    0.274    0.088    0.000    0.000    0.000    0:03:55    0:38:28
12 5    N010    0.622    0.196    0.092    0.000    0.000    0.000    0:03:23    0:41:53
13 6    N010    0.573    0.195    0.087    0.000    0.000    0.000    0:02:47    0:44:42
14 7    N010    0.400    0.117    0.049    0.000    0.000    0.000    0:02:01    0:46:46
15 8    N010    0.278    0.093    0.066    0.000    0.000    0.000    0:01:45    0:48:32
16 9    N020    0.238    0.082    0.020    0.000    0.000    0.000    0:01:41    0:50:15
17 10   N123    0.140    0.046    0.030    0.000    0.000    0.000    0:02:03    0:52:21

38 31   N010    0.011    0.002    0.001    0.000    0.000    0.000    0:01:25    1:20:13
39 32   N100    0.007    0.002    0.001    0.000    0.000    0.000    0:01:34    1:21:49
40 33   N110    0.005    0.001    0.001    0.000    0.000    0.000    0:01:23    1:23:13
41 34   N100    0.003    0.001    0.000    0.000    0.000    0.000    0:00:59    1:24:14
42 35   Y000    0.002    0.001    0.000    0.000    0.000    0.000    0:01:22    1:25:38
43 -----
44 > Convergence criteria met!

```

Running time – CTAX (full)

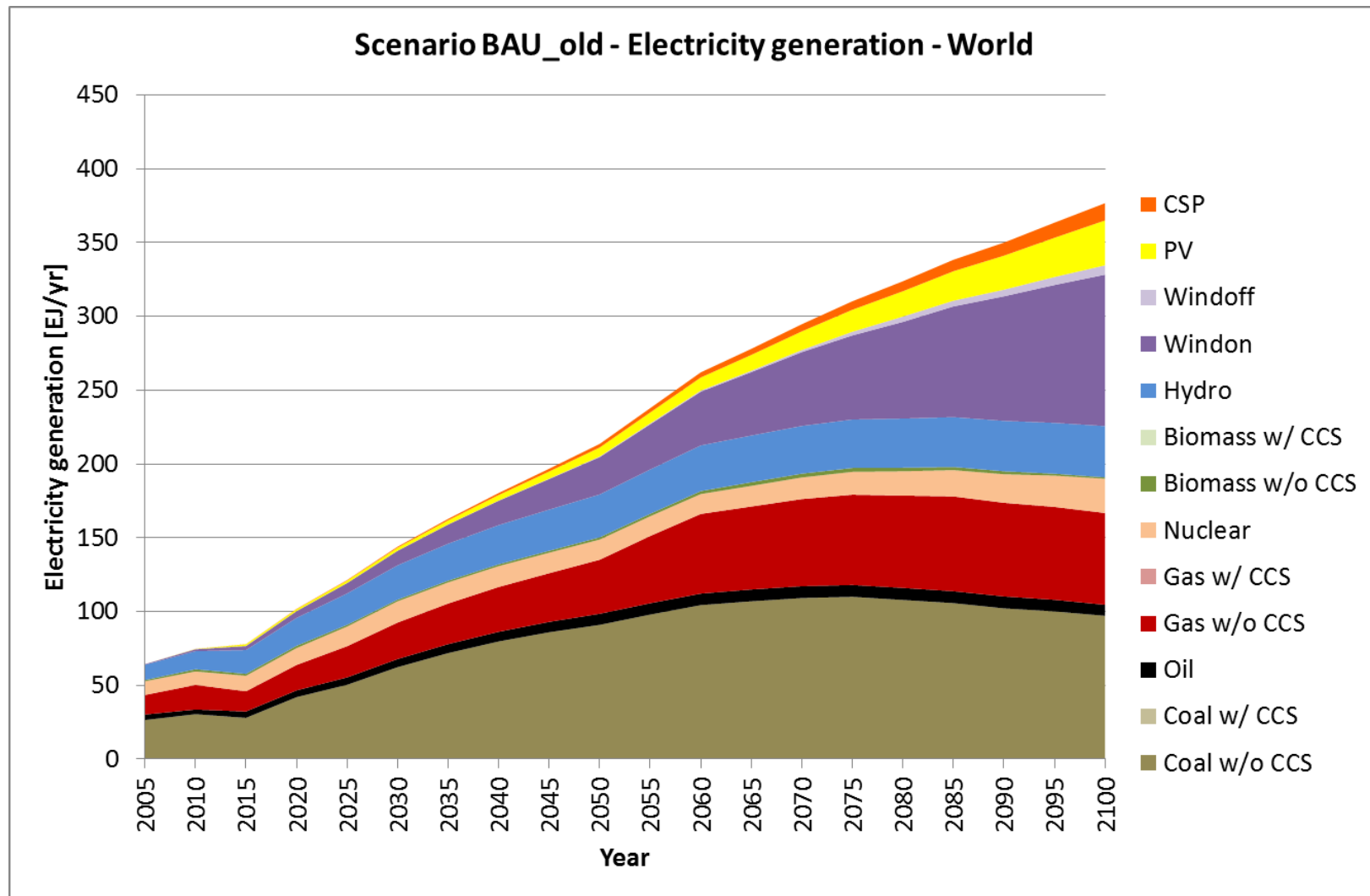
Starting from the correct result

```
1 Start: 05/18/18 12:53:43
2 To run: tax1
3 sol: [Y/N][clt nonopt][clt infes][tot infes]
4 =====
5 iter  sol      inv      pes      oil      nip      co2      wgt  itertime  totime
6      |      |      |      |      |      |      |      |      |
7 >tax -----
8 1  N100    0.962    0.093    0.025    0.000    0.000    0.000    0:40:29  0:40:45
9 2  N100    1.188    0.203    0.103    0.000    0.000    0.000    0:05:42  0:46:39
10 3  N200    0.565    0.116    0.025    0.000    0.000    0.000    0:04:59  0:51:49
11 4  N100    0.251    0.056    0.026    0.000    0.000    0.000    0:01:59  0:53:59
12 5  Y000    0.151    0.055    0.025    0.000    0.000    0.000    0:02:35  0:56:44
13 6  Y000    0.162    0.076    0.043    0.000    0.000    0.000    0:01:35  0:58:30
14 7  Y000    0.133    0.054    0.013    0.000    0.000    0.000    0:01:52  1:00:33
15 8  N100    0.076    0.024    0.014    0.000    0.000    0.000    0:01:50  1:02:35
16 9  Y000    0.066    0.027    0.012    0.000    0.000    0.000    0:01:46  1:04:32
17 10 Y000    0.045    0.020    0.008    0.000    0.000    0.000    0:01:15  1:05:58
18 11 Y000    0.039    0.014    0.007    0.000    0.000    0.000    0:01:18  1:07:28
19 12 N100    0.010    0.001    0.007    0.000    0.000    0.000    0:01:22  1:09:02
20 13 Y000    0.027    0.011    0.005    0.000    0.000    0.000    0:01:01  1:10:16
21 14 Y000    0.007    0.001    0.005    0.000    0.000    0.000    0:01:06  1:11:34
22 -----
23 > Convergence criteria met!
24 =====
25
```

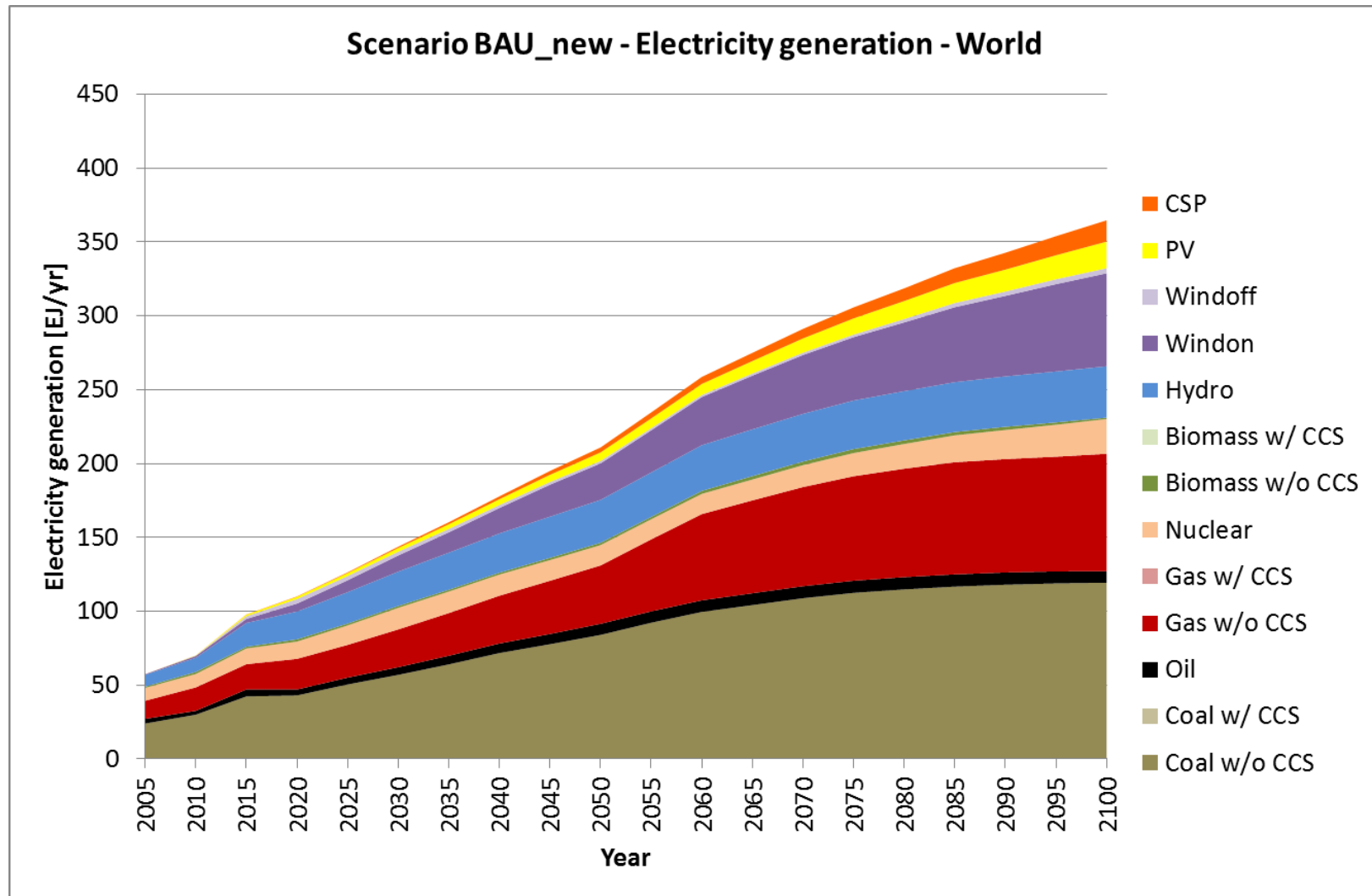
General considerations

- In its current version, the code has a major flaw: if one runs the model, and the re-runs it once again starting from the resulting.gdx without changing anything, the run produces a lot of infeasibilities and converges only after a lot of time (even hours).
- Apparently a huge number of variables are overwritten in the starting phase.
- This does not seem related (only) to the renewables module, but (also) to CCS (infeasibilities in te) – and possibly DAC?
- It is therefore complicated to fully assess the impacts of the changes in the renewables mode until this issue has been solved.

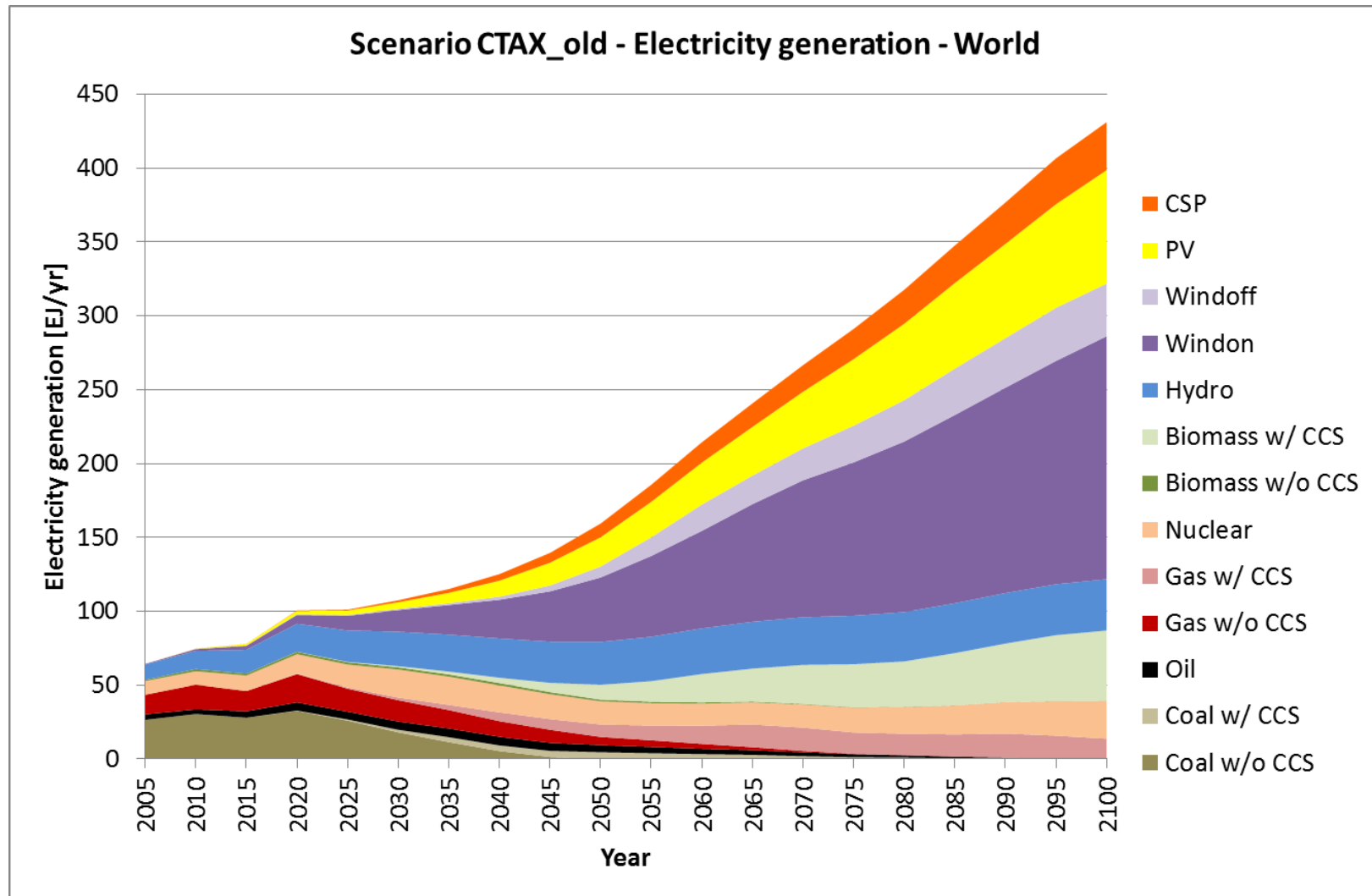
Electricity mix – BAU (old)



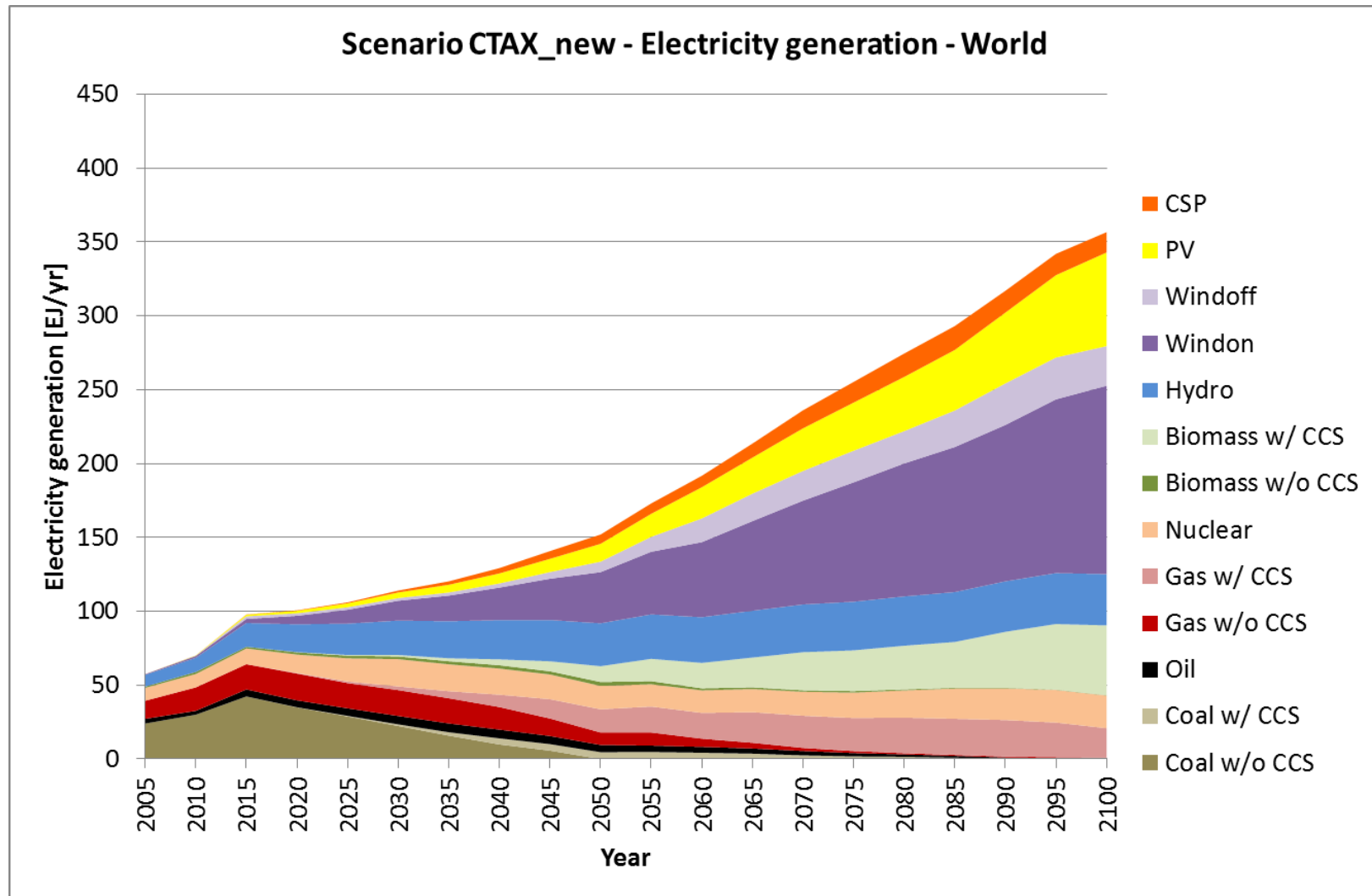
Electricity mix – BAU (full)



Electricity mix – CTAX (old)



Electricity mix – CTAX (full)



To-do-list

1. Clarify the origin of the infeasibilities (DAC, CCS, etc.)
2. Complete the alignment between the two versions
3. Substitute .fx with .I.
4. Move the heaviest equations out of the optimization (flexibility and capacity constraints)



**THANK YOU
FOR YOUR ATTENTION**

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