User Manual for SSG Power Simulation 2

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Preface

This program has been developed at Aalborg University on behalf of WAVEenergy AS, Norway as phase 5 of the cooperation contract.

This manual gives a detailed description of the use of the computer program *SSG Power Simulation 2*. Furthermore, the underlying mathematics and algorithms are briefly described. The program is based on experimental data from model testing of Seawave Slot-Cone Generator (SSG) presented in Kofoed (April 2005) and Kofoed (June 2005).

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Aalborg, 12 June 2006

Content

1 Symbols

Symbol	*Unit*		*Description*
$\mu_{turb,j}$	[m^3/s]	:	Turbine efficiency in a time step
A, B, C		:	Constants used in formula for estimating mean overtopping for a reservoir. The value used are $A = 0.197$, $B = -1.753$ and $C = -0.408$.
$A_{res,j}$	[m^2]	:	Area of reservoir
c		:	Constant $c = 1.21$
f_n	[m]	:	Freespace. Distance between the crest and the water surface inside the reservoir. The magnitude of freespace is used to control turbine activation.
g	[m/s^2]	:	Gravity acceleration $g=9.82$
$\overline{h}_j$	[m]	:	Mean head for reservoir j
h_j	[m]	:	Actual head in reservoir j at the beginning of the time step
h_n	[m]	:	Head. Distance between water surface in reservoir and MVL. The head is used to determine turbine production.
H_s	[m]	:	Significant wave height
j		:	Counter of reservoirs
MWL	[m]	:	Mean water level
$N_{reservoirs}$		:	Number of reservoirs
$N_{substeps}$		:	Number of time steps in each wave period
N_{waves}		:	Number of waves
P	[W]	:	Power
P_{ov}		:	Probability that a wave does not overtop the crest of the reservoir
P_{turb}	[W]	:	Total mean Power production
$p_{turb,j}$	[W]	:	Mean Power production in a time step
p_w		:	Random number
q	[m^3/s]	:	Mean water flow into reservoir
Q_{in}	[m^3/s]	:	Overtopping from wave
q_{in}	[m^3/s]	:	Overtopping flow in wave
$q_{in,j}$	[m^3/s]	:	Overtopping flow in a time step
Q_{over}	[m^3/s]	:	Total mean reservoir overflow
Q_{res}	[m^3/s]	:	Total mean flow change in reservoir
Q_{turb}	[m^3/s]	:	Total mean turbine flow
$q_{turb,j}$	[m^3/s]	:	Flow through turbine in a time step
$Q_{upper.over}$	[m^3/s]	:	Spillage from upper reservoir
R_c	[m]	:	Crest freeboard height
$R_{c.n}$	[m]	:	Crest level of the reservoir
T_e	[s]	:	Energy period $T_e = T_p / 1.15$
T_m	[s]	:	Mean wave period $T_m = \dfrac{T_p}{1.2}$
T_p	[s]	:	Peak wave period
z_1	[m]	:	Lower vertical boundary of the reservoir, which corre-

Symbol	*Unit*		*Description*
			spond to the crest level, $z_1 = R_{c,n}$
z_2	[m]	:	Upper vertical boundary of the reservoir, which correspond to the crest level of the upper reservoir, $z_2 = R_{c,n+1}$. For the uppermost reservoir, the upper boundary is in principle infinite, but the program uses twice the lower boundary $z_2 = 2z_1$.
η_j		:	Efficiency of the turbines in reservoir j
ρ	[kg/m^3]	:	Density of seawater $\rho=1025$

2 Introduction

Seawave Slot-Cone Generator is a wave energy converter of the overtopping type. Water from the waves is captured in a number of reservoirs above the mean water level. The potential energy is transformed to electrical energy when the water is led through a turbine on its way back to the sea.

SSG Power simulation 2 is a complete rewrite version 1, with increased flexibility and performance in mind. The program simulates a time series of overtopping into the reservoirs and the energy produced by the turbines.

The intention of the program is to allow the user to determine the optimal geometry and turbine strategy by simulation. Therefore, the user can alter various parameters describing geometry, sea state, turbine configuration and turbine strategy. Based on the parameters the program simulates wave series and generates a report containing:

- Water volume/flow into each reservoir
- Water volume/flow through each turbine
- Spillage volume/flow when the reservoirs are full
- Produced energy
- Average power
- Hydraulic efficiency of overtopping into reservoirs
- Efficiency of the reservoirs
- Efficiency of the turbines
- Total efficiency

Optionally plots of water movement and power generation for every time step can be produced.

3 Numerical model

3.1 Geometry

The SSG2 program is capable of simulating a Sea Slot-cone structure with *n* reservoirs, each reservoir with an independent turbine setup. A sketch of the geometry with indication of the governing symbols is shown in Figure 1:

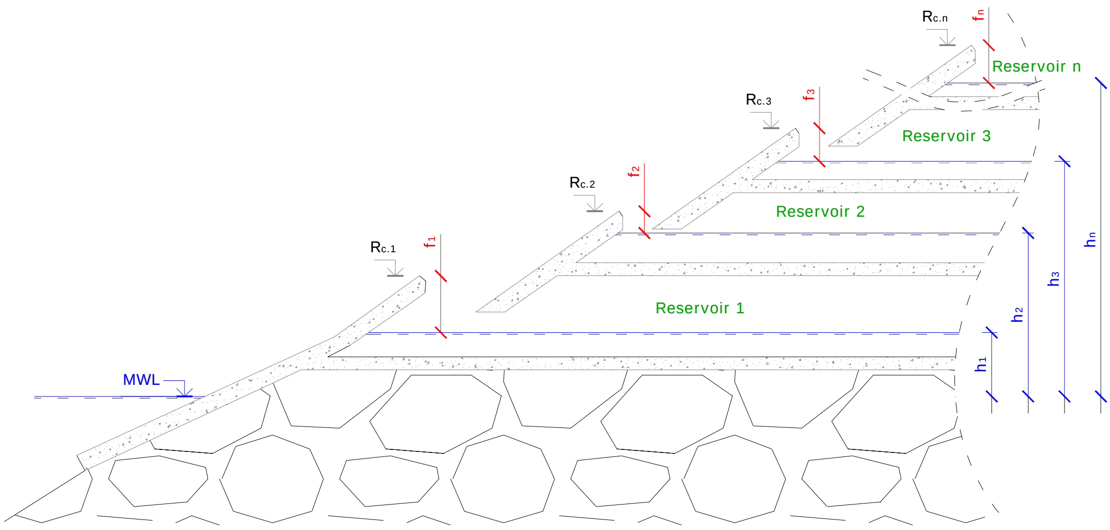


Figure 1 SSG Geometry sketch

Where:

Symbol	*Unit*		*Description*
MWL	[m]	:	Mean water level
$R_{c.n}$	[m]	:	Crest level of the reservoir
f_n	[m]	:	Freespace. Distance between the crest and the water surface inside the reservoir. The magnitude of freespace is used to control turbine activation.
h_n	[m]	:	Head. Distance between water surface in reservoir and MVL. The head is used to determine turbine production.

The size of each reservoir is also important for the outcome of the simulation. Therefore, reservoir length (along the waterfront) and width (perpendicular to waterfront) are also needed as input to the simulation.

3.2 Continuity equation

The program is based on the continuity equation

$$Q_{in} = Q_{over} + Q_{turb} + Q_{res} \tag{1}$$

Or with *overflow to next reservoir* enabled, the extended version

$$Q_{in} + Q_{upper.over} = Q_{over} + Q_{turb} + Q_{res} \tag{2}$$

Where:

Symbol	Unit		Description
Q_{in}	[m³/s]	:	Overtopping from wave
$Q_{upper.over}$	[m³/s]	:	Spillage from upper reservoir
Q_{over}	[m³/s]	:	Overflow if reservoir is full
Q_{turb}	[m³/s]	:	Flow through turbines
Q_{res}	[m³/s]	:	Flow in reservoir

The continuity equation must be satisfied in each time step and for each separate reservoir.

If *overflow to next reservoir* (see section 4.1.1) is disabled finding the flows for the full structure is as easy as summing up the flows for all reservoirs. If *overflow to next reservoir* is enabled, it is a bit trickier, since overflow water from upper reservoirs is reused. Therefore, when *overflow to next reservoir* is enabled, the overflow of the lowest reservoir alone represents the full overflow of the structure.

The following sections describe how the flows are determined.

3.3 Experimental data

Generation of the time series is based on the mean water flow into each reservoir. The mean water flow is found by experiments with a model of SSG. According to Kofoed (April 2005) the mean water flow into the nth reservoir can be estimated using:

$$q_n(z_1, z_2) = \sqrt{gH_s^{\,3}}\,\frac{A}{B}e^{C\frac{R_{c,1}}{H_s}}\left(e^{B\frac{z_2}{H_s}} - e^{B\frac{z_1}{H_s}}\right) \tag{3}$$

Where:

Symbol	Unit		Description
g	[m/s²]	:	Gravity acceleration, g = 9.82
H_s	[m]	:	Significant wave height
z_1	[m]	:	Lower vertical boundary of the reservoir, which correspond to the crest level, $z_1 = R_{c,n}$
z_2	[m]	:	Upper vertical boundary of the reservoir, which correspond to the crest level of the upper reservoir, $z_2 = R_{c,n+1}$. For the uppermost reservoir, the upper boundary is in principle infinite, but the program uses twice the lower boundary $z_2 = 2z_1$.

Symbol	*Unit*		*Description*
A, B, C		:	Constants found by non-linear regression analysis. The value used are $A = 0.197$, $B = -1.753$ and $C = -0.408$.

A newer set of data presented in Kofoed (June 2005) is showing better performance of SSG with a structure consisting of 3 reservoirs with crest levels of 1.5, 3 and 5 meters. In Figure 3 the new data has been idealized and are compared to formula (3).

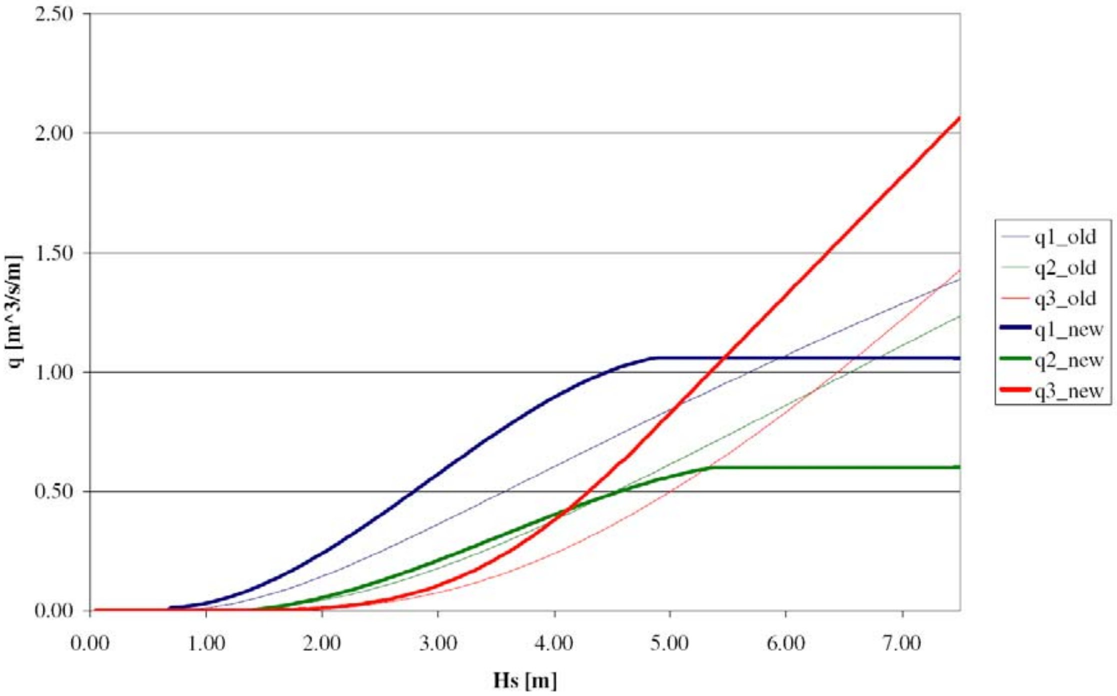


Figure 2 Comparison of experimental data from Kofoed (April 2005) and Kofoed (June 2005).

3.4 Generation of time series

As described in Jacobsen and Frigaard (1999) the wave overtopping is given by a random process compiled of two steps. References are made to Franco et al. (1994) and van der Meer and Jansen (1995) from which the equations are cited

$$P_{ov} = e^{\left(-\left(c\frac{H_s}{R_c}\right)^{-2}\right)} \qquad (4)$$

$$q_{in} = 0.84\frac{q}{P_{ov}}\left(-\ln(1-p_w)\right)^{0.75} \qquad (5)$$

Where:

Symbol	Unit		Description
P_{ov}		:	Probability that a wave does not overtop the crest of the reservoir
c		:	Constant $c = 1.21$
R_c	[m]	:	Crest freeboard height
q_{in}	[m^3/s]	:	Overtopping flow in wave
q	[m^3/s]	:	Mean water flow into reservoir
T_p	[s]	:	Peak wave period
T_m	[s]	:	Mean wave period $T_m = \frac{T_p}{1.2}$
p_w		:	Random number

The overtopping flow of a wave is determined by Algorithm 1.

Input **:** H_s, T_p and R_c
Output **:** q_{in}

$$P_{ov} = e^{\left(-\left(c\frac{H_s}{R_c}\right)^{-2}\right)}$$

$q = q(H_s, R_c)$ is determined from experimental data in section 3.3
p = new random number
if $p > p_{ov}$ **then**
p_w = new random number

$$q_{in} = 0.84\frac{q}{P_{ov}}\left(-\ln(1-p_w)\right)^{0.75}$$

else
$q_{in} = 0$
end

Algorithm 1, Calculation of overtopping volume from a single wave.

For every wave, the program calculates the overtopping flow into each reservoir.

3.5 Turbine characteristics

The turbine characteristics describe the relationship between the head, flow and efficiency of the turbine. The turbine characteristic is used to determine the flow and efficiency at a given head.

The flow through the turbines depend on the head which constantly changes when water passes through the turbine, for simplification the flow is either based on initial head or an estimated average head. If the gradient of the turbine characteristic is large, the error of the simplification may be significant. To minimize the error of the simplification each wave period is divided into a user-specified number of time steps.

3.6 Turbine strategy

The turbine strategy determines when the turbines start and stop. The turbine strategy is based on a term called freespace *f* (see Figure 1), which is defined as the distance between the crest of the reservoir and water surface inside the reservoir.

Turbine activation is done according to a linear function, which has the wave height as input.

If $f < f_{on}(H_s)$ then
Start turbine

Where:
$f_{on}(H_s) = \text{Min}(\text{Max}((A \cdot H_s + B), C), D)$
$A =$ Turbine on *Hs* gain
$B =$ Turbine on *Hs* offset
$C =$ Turbine on lower limit
$D =$ Turbine on upper limit

Setting *C* = *D* will disable influence from wave-height. Turning off the turbines is controlled in similar fashion:

If $f > f_{off}(H_s)$ then
Start turbine

Where:
$f_{off}(H_s) = \text{Min}(\text{Max}((A \cdot H_s + B), C), D)$
$A =$ Turbine on *Hs* gain
$B =$ Turbine on *Hs* offset
$C =$ Turbine on lower limit
$D =$ Turbine on upper limit

3.7 Produced energy

The produced power in each time step is calculated using

$$P = \sum_{j=1}^{N_{\text{Reservoirs}}} \rho\, g\, h_j\ q_{\text{turb},j}(h_j)\ \eta_j(h_j) \qquad (6)$$

Where:

Symbol	Unit		Description
$N_{reservoirs}$		:	Number of reservoirs
P	[W]	:	Power
j		:	Counter of reservoirs
ρ	[kg/m³]	:	Density of seawater $\rho=1025$

g	$[m/s^2]$	:	Gravity acceleration, $g=9.82$
h_j	[m]	:	Actual head in reservoir j at the beginning of the time step
$q_{turb,j}(h_j)$	$[m^3/s]$	:	Flow through the turbine in reservoir j as a function of head
$\eta_j(h_j)$		:	Efficiency of the turbine in reservoir j as a function of head

3.8 Simulation algorithm

The principle of the algorithm for simulating power production is outlined in Algorithm 2. The reservoirs are indicated by subscript j.

Input : H_s, T_p, N_{waves}, $N_{substeps}$, geometry and turbine characteristics
Output : Q_{in}, Q_{turb}, Q_{res} and P_{Turb}
// Calculate constant parameters in the time series:

$$T_m = \frac{T_p}{1.2}$$

$$\Delta t = \frac{T_m}{N_{steps}}$$

for $j = 1$ .. $N_{reservoirs}$ **do**

$$P_{ov,J} = e^{\left(-\left(c\frac{H_s}{R_{c,J}}\right)^{-2}\right)}$$

end
Determine mean water flow q_j into each reservoir
// Loops to generate time series:
for $k = 1$ .. N_{waves} **do**
  p = new random number
  p_w = new random number
  // Loop over number of reservoirs:
  for $j = 1$ .. $N_{reservoirs}$ **do**
    if $p > P_{ov,j}$ **then**

$$q_{in} = 0.84\frac{q_j}{P_{ov,j}}\left(-\ln(1-p_w)\right)^{0.75}$$

    else

$$q_{in} = 0$$

    end
    for $m = 1$ .. $N_{substeps}$ **do**
      // Determine current head depending of crest height and current freespace

$$h = R_{c,j} - f_j$$

      // Determine if turbines should be turned on in the current time step
      if $f_j < F_{on}(H_s)$ **then**
        Start turbine j
      end
      if $f_j > F_{off}(H_s)$ **then**
        Stop turbine j
      end
      if Turbines turned on **then**
        (q_{turb}, η_{turb}) = TurbineCharacteristic(h)
      else
        (q_{turb}, η_{turb}) = (0, 0)

end

$$f_{res,j} += \frac{(q_{in,j} - q_{turb,j})\Delta t}{A_{res,j}}$$

if $f_{res,j} < 0$ **then**

$$q_{over} = \frac{f_{res,j}\, A_{res,j}}{\Delta t}$$

$f_{res,j} = 0$

end

$$Q_{in,j} += q_{in}$$

$$Q_{turb,j} += q_{turb}$$

$$Q_{over,j} += q_{over}$$

$$Q_{res,j} += q_{in} - q_{over} - q_{turb}$$

$$P_{Turb,j} += q_{turb}\, g\, \rho\, h\, \eta_{turb}$$

end

end

end

for $j = 1 .. N_{reservoirs}$ **do**

$$Q_{in,j} /= T_m N_{waves}$$

$$Q_{over,j} /= T_m N_{waves}$$

$$Q_{res,j} /= T_m N_{waves}$$

$$Q_{turb,j} /= T_m N_{waves}$$

$$P_{turb,j} /= T_m N_{waves}$$

end

Algorithm 2, Main algorithm to compute produced electrical energy.

The following not previously defined symbols are used.

Symbol	*Unit*		*Description*
$N_{substeps}$		:	Number of time steps in each wave period
N_{waves}		:	Number of waves
$A_{res,j}$	[m^2]	:	Area of reservoir
$q_{in,j}$	[m^3/s]	:	Overtopping flow in a time step
$q_{turb,j}$	[m^3/s]	:	Flow through turbine in a time step
$\mu_{turb,j}$	[m^3/s]	:	Turbine efficiency in a time step
$p_{turb,j}$	[W]	:	Mean Power production in a time step
Q_{in}	[m^3/s]	:	Total mean flow in
Q_{turb}	[m^3/s]	:	Total mean turbine flow
Q_{res}	[m^3/s]	:	Total mean flow change in reservoir
Q_{over}	[m^3/s]	:	Total mean reservoir overflow
P_{turb}	[W]	:	Total mean Power production

3.9 Efficiencies

According to Falnes, referred to in Kofoed (April 2005), the total available energy per second per meter wave front is:

$$P_{wave} = \frac{\rho g^2}{64\pi} T_e H_s^2 \qquad (7)$$

Where:

Symbol	Unit		Description
T_e	[s]	:	Energy period $T_e = T_p / 1.15$

The efficiency of the SSG is determined at three levels:

- Potential energy overtopping the crests
- Potential energy stored in the reservoirs. This will be less than above, because the head of the reservoir water surface is less than the crest level. If the head reaches crest level, overflow happens and potential energy will be lost.
- Energy transformed into kinetic energy by turbines. This will be less than above, due to start/stop penalties and turbine efficiency generally below 100%.

The efficiencies are determined by (8), (10) and (12):

$$\eta_{in} = \frac{P_{in}}{P_{wave}} \qquad (8)$$

where

$$P_{in} = \sum_{j=1}^{N_{reservoirs}} Q_{in,j}\, R_j\, \rho\, g \qquad (9)$$

$$\eta_{res} = \frac{P_{res}}{P_{wave}} \qquad (10)$$

where

$$P_{res} = \sum_{j=1}^{N_{reservoirs}} \left(Q_{in,j} - Q_{over,j}\right)\overline{h_j}\, \rho\, g \qquad (11)$$

$$\eta_{turb} = \frac{P_{turb}}{P_{wave}} \qquad (12)$$

where

$$P_{turb} = \sum_{j=1}^{N_{reservoirs}} P_{turb,j} \qquad (13)$$

Where:

Symbol	Unit		Description
$\overline{h_j}$	[m]	:	Mean head for reservoir j
$P_{turb,j}$	[W]	:	The cumulated mean power of reservoir j, as found in Algorithm 2

4 Use of the program

SSG2 program can perform a series of SSG simulations. The program starts with an empty simulation list.

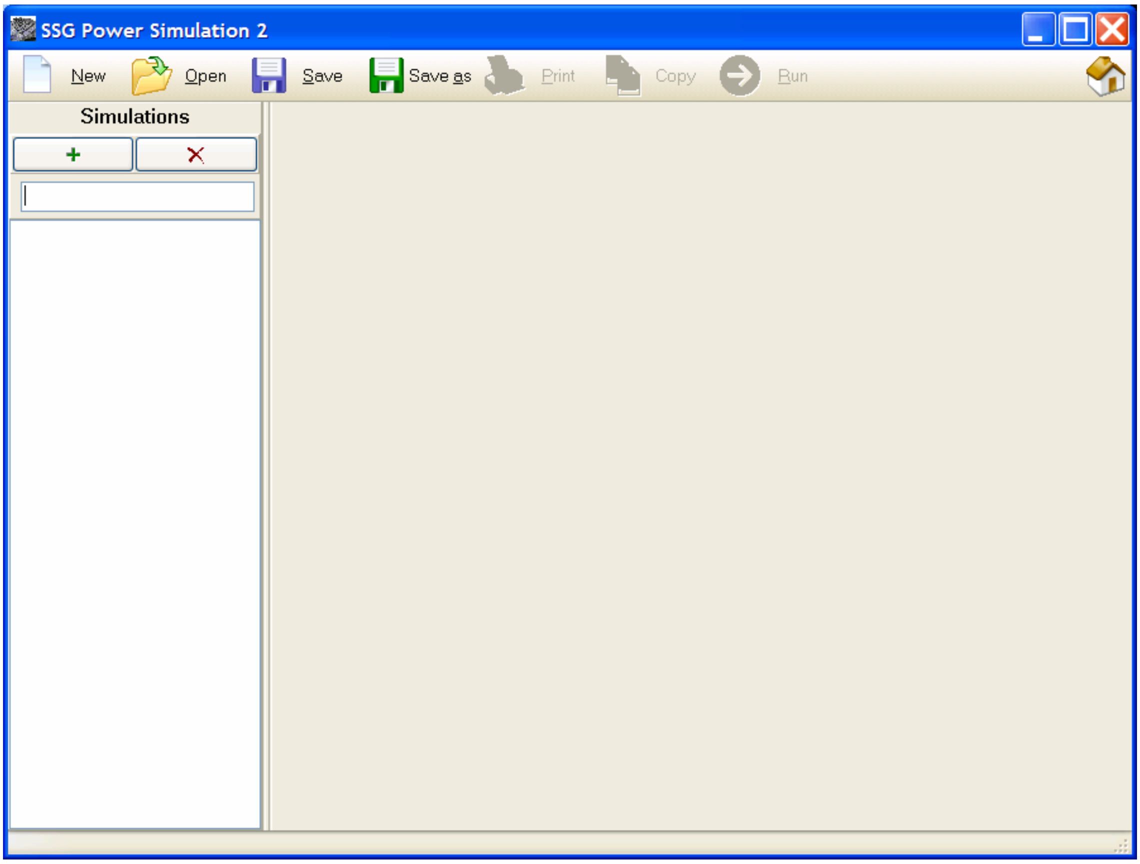
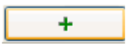


Figure 3, the SSG2 program with empty simulation list

A new simulation can be initiated by pressing  or a previous simulation list can be loaded for modification. The main form will then open up for the necessary input fields described in the following section.

4.1 Input parameters

Initiating a new simulation will transform the appearance of SSG2.

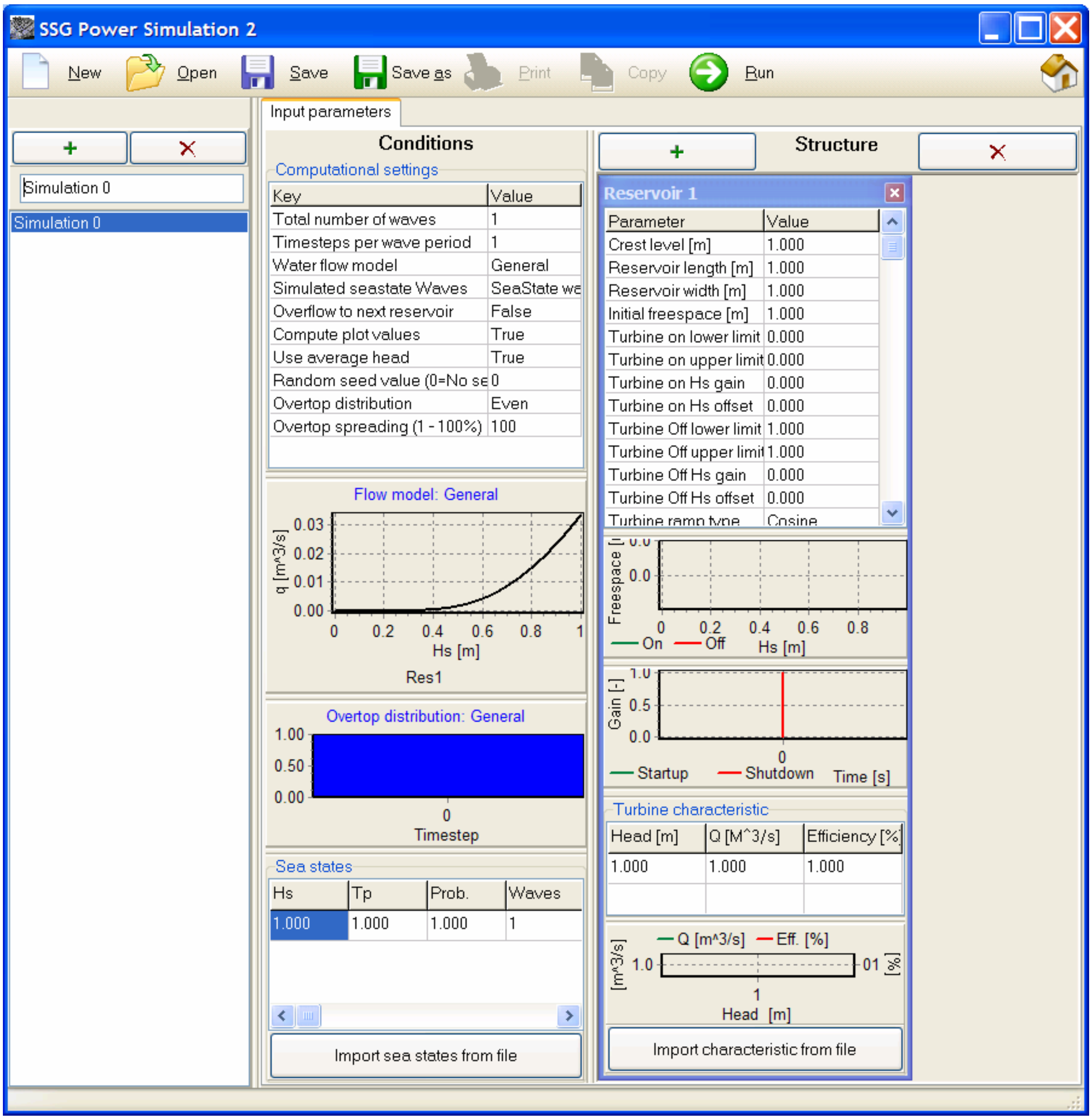


Figure 4, the SSG2 program with newly initiated simulation list

The simulation parameters are split into two main parts:

Conditions:

Parameters controlling simulations conditions. This includes:

- Sea-states
- Number of waves to simulate
- Computation specific parameters

Structure:

Geometry and configurations of the structure. This includes:

- Number of reservoirs
- Reservoir geometries
- Turbine configuration

4.1.1 Conditions

The simulation conditions are made up of computational conditions and sea-states to simulate.

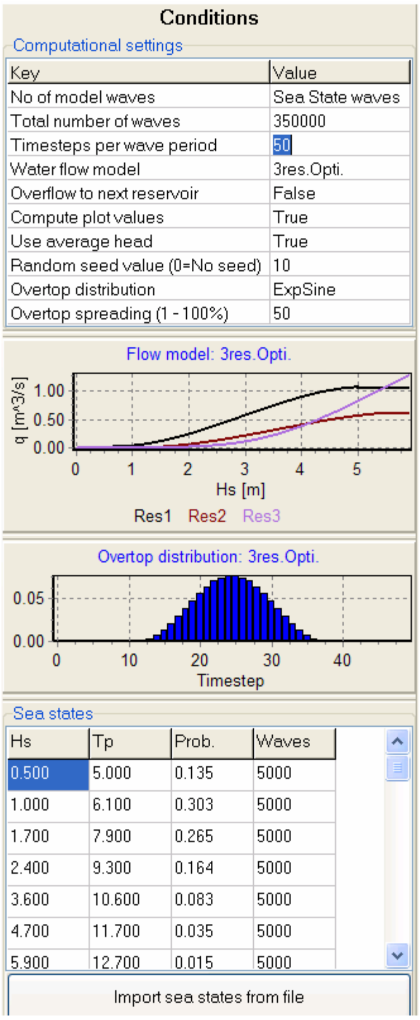


Figure 5, Condition panel.

Computational settings:

Parameter		*Description*
No of model waves	:	How the number of simulated waves are entered: **Sea State waves:** Uses the *Waves* column from the sea states grid. **Prob of total:** The *Total number of waves* is covering all sea states. The number of waves per sea-state is hereby computed from the probability in the time domain.
Total number of waves	:	Used when *No of model waves* is set to *Prob of total*. See description for *No of model waves*
Time steps per wave period	:	Number of sub-step each wave is divided into during the simulation. More sub-steps results that are more precise at the cost of longer computations time.
Water flow model	:	Which water model to use (see section 3.3). **General:** Model based on experimental data from Kofoed (April 2005) **3res.Opti.:** Model based on experimental data from Kofoed (June 2005). This model is optimized for a specific geometry and gives better results this geometry. The geometry is locked to 3 reservoirs with Crest levels of 1.5m, 3m and 5m. The amount of overtopping discharge for each reservoir depending on the significant wave height is illustrated graphically on a chart below the parameters.
Overflow to next reservoir	:	If enabled, spillage from upper reservoirs will be added to the amount of incoming water in the reservoir below.
Compute plot values	:	If activated, state values are stored for all time steps. This can be used to produce charts for water movement, energy production and turbine efficiency. Notice that this is not especially time consuming but very memory intensive and the number of possible time steps will be limited by the installed amount of memory in the computer.
Use average head	:	If *deactivated*, the head used for turbine characteristic is the head at the beginning of the time step. If *activated*, the head used for turbine characteristic is reduced to an estimated mean, using the head before and after a normal time step. In theory, this should be more realistic.

Parameter		*Description*
Random seed value	:	The overtopping formula is given by a random process (see section 3.4). Setting a seed value, allows repeating the exact same series of random numbers and hereby the overtopping discharges used (if sea-states and number of waves remain unchanged). This eliminates the uncertainty of random noise when doing parameter optimization.
Overtop distribution	:	How the overtop discharge is modelled throughout a wave period. The distribution on all sub steps of a wave is illustrated graphically on a chart below the parameters.
Overtop spreading	:	Percentage of wave period with overtopping discharge.

Sea states:

Parameter	*unit*		*Description*
Hs	[m]	:	Significant wave height
Tp	[s]	:	Peak period
Prob.		:	Probability of that sea state
Waves		:	Number of waves to base the results on; see description for *simulated sea state waves* under computational settings.

Sea states can be added and removed, by right clicking with the mouse and selecting from a popup-menu or using the <INSERT> and <DELETE> keys. Sea states can be imported from text file in the format:

```
Hs        Tp        Prob      No waves
0.5       5.0       0.135     20000
1.0       6.1       0.303     20000
.         .         .         .
.         .         .         .
.         .         .         .
```

4.1.2 Structure

The structure of the Seawave slot-cone generator is built up by a series of reservoirs on top of each other (see Figure 1). The number of reservoirs is changed by pressing the add- or remove-button in top of the panel.

Figure 6, Structure panel.

Parameters:

Parameter	*Unit*		*Description*
Crest level	[m]	:	Distance from mean sea-water level (MWL) to crest of reservoir
Reservoir Length	[m]	:	The length of the reservoir along the water front
Reservoir width	[m]	:	The length of the reservoir perpendicular to the water front

Parameter	*Unit*		*Description*
Initial freespace	[m]	:	The distance between reservoir crest and water surface inside reservoir at simulation start.
Turbine on lower limit	[m]	:	Turbine activation is done according to a linear function, see section 3.6 for more information
Turbine on upper limit	[m]	:	- see above -
Turbine on Hs gain	[-]	:	- see above -
Turbine on Hs offset	[m]	:	- see above -
Turbine off lower limit	[m]	:	- see above -
Turbine off upper limit	[m]	:	- see above -
Turbine off Hs gain	[-]	:	- see above -
Turbine off Hs offset	[m]	:	- see above -
Turbine ramp type		:	Ramp type defines how the starting up and shutting down of the turbine should be modelled in order to introduce a start/stop penalty **CstReduc:** The turbine is working at half its capacity **Linear:** The turbine characteristic scales linear with the start/stop time **Cosine:** The turbine characteristic scales according to a cosine function with the start/stop time.
Turbine start up time	[s]	:	Start up time for the turbine. Zero seconds will result in no penalty for starting up.
Turbine shutdown time	[s]	:	Shutdown time for the turbine. Zero seconds will result in no penalty for shutting down.
Turbine produce power on start up		:	If enabled, the turbine will produce power during its start up.

Turbine characteristic:

Parameter	*Unit*		*Description*
Head	[m]	:	Head of incoming water
Q	[m^3/s]	:	Turbine throughput at current head
Efficiency	[%]	:	Turbine efficiency at current head

Turbine characteristic can be imported from text file in the format:

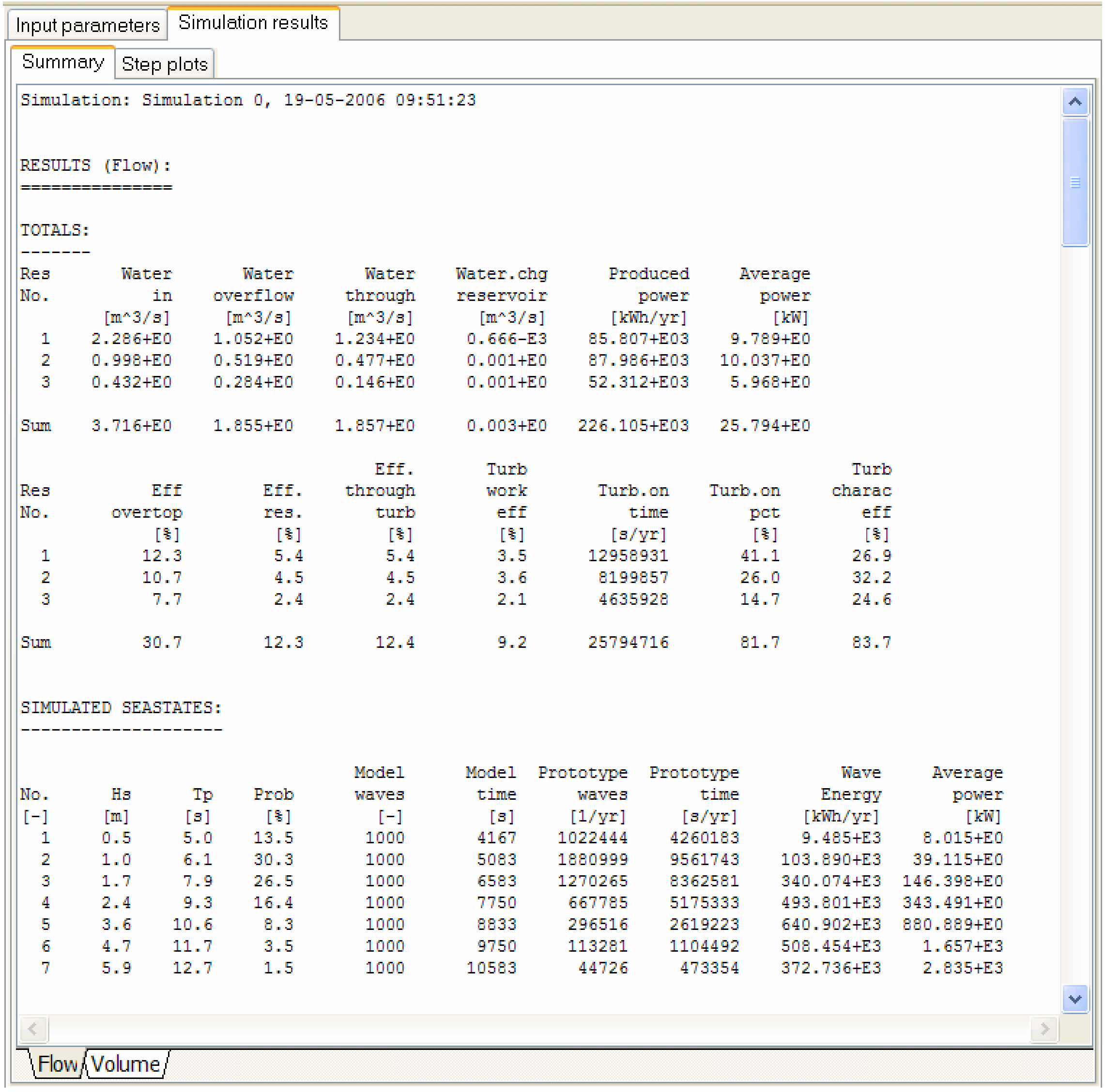
```
H[m]    Q[m^3/s]   eta[%]
0.500   3.342      60.4
0.625   3.491      75.6
0.750   3.625      83.2
0.875   3.748      87.0
1.000   3.864      88.9
1.125   3.974      89.6
1.250   4.078      89.7
1.375   4.178      89.4
1.500   4.275      88.8
```

4.2 Simulations results

After a simulation has been completed, a new tab called *Simulation results* appears (next to the *Input parameters* tab), where the results are presented. The results are presented in two ways.

1. A summary report.
2. Step plots (if *Compute plot values* were enabled).

4.2.1 Summary



Simulation: Simulation 0, 19-05-2006 09:51:23

RESULTS (Flow):
===============

TOTALS:

Res No.	Water in [m^3/s]	Water overflow [m^3/s]	Water through [m^3/s]	Water.chg reservoir [m^3/s]	Produced power [kWh/yr]	Average power [kW]
1	2.286+E0	1.052+E0	1.234+E0	0.666-E3	85.807+E03	9.789+E0
2	0.998+E0	0.519+E0	0.477+E0	0.001+E0	87.986+E03	10.037+E0
3	0.432+E0	0.284+E0	0.146+E0	0.001+E0	52.312+E03	5.968+E0
Sum	3.716+E0	1.855+E0	1.857+E0	0.003+E0	226.105+E03	25.794+E0

Res No.	Eff overtop [%]	Eff. res. [%]	Eff. through turb [%]	Turb work eff [%]	Turb.on time [s/yr]	Turb.on pct [%]	Turb charac eff [%]
1	12.3	5.4	5.4	3.5	12958931	41.1	26.9
2	10.7	4.5	4.5	3.6	8199857	26.0	32.2
3	7.7	2.4	2.4	2.1	4635928	14.7	24.6
Sum	30.7	12.3	12.4	9.2	25794716	81.7	83.7

SIMULATED SEASTATES:

No. [-]	Hs [m]	Tp [s]	Prob [%]	Model waves [-]	Model time [s]	Prototype waves [1/yr]	Prototype time [s/yr]	Wave Energy [kWh/yr]	Average power [kW]
1	0.5	5.0	13.5	1000	4167	1022444	4260183	9.485+E3	8.015+E0
2	1.0	6.1	30.3	1000	5083	1880999	9561743	103.890+E3	39.115+E0
3	1.7	7.9	26.5	1000	6583	1270265	8362581	340.074+E3	146.398+E0
4	2.4	9.3	16.4	1000	7750	667785	5175333	493.801+E3	343.491+E0
5	3.6	10.6	8.3	1000	8833	296516	2619223	640.902+E3	880.889+E0
6	4.7	11.7	3.5	1000	9750	113281	1104492	508.454+E3	1.657+E3
7	5.9	12.7	1.5	1000	10583	44726	473354	372.736+E3	2.835+E3

Figure 7, Summary report.

The summary tab presents the simulation results in report format. The units of the report can be changed by choosing the flow- or volume-tab at the bottom.

4.2.2 Step plots

If *Compute plot values* where enabled during simulation it is possible to make *Step plots*.

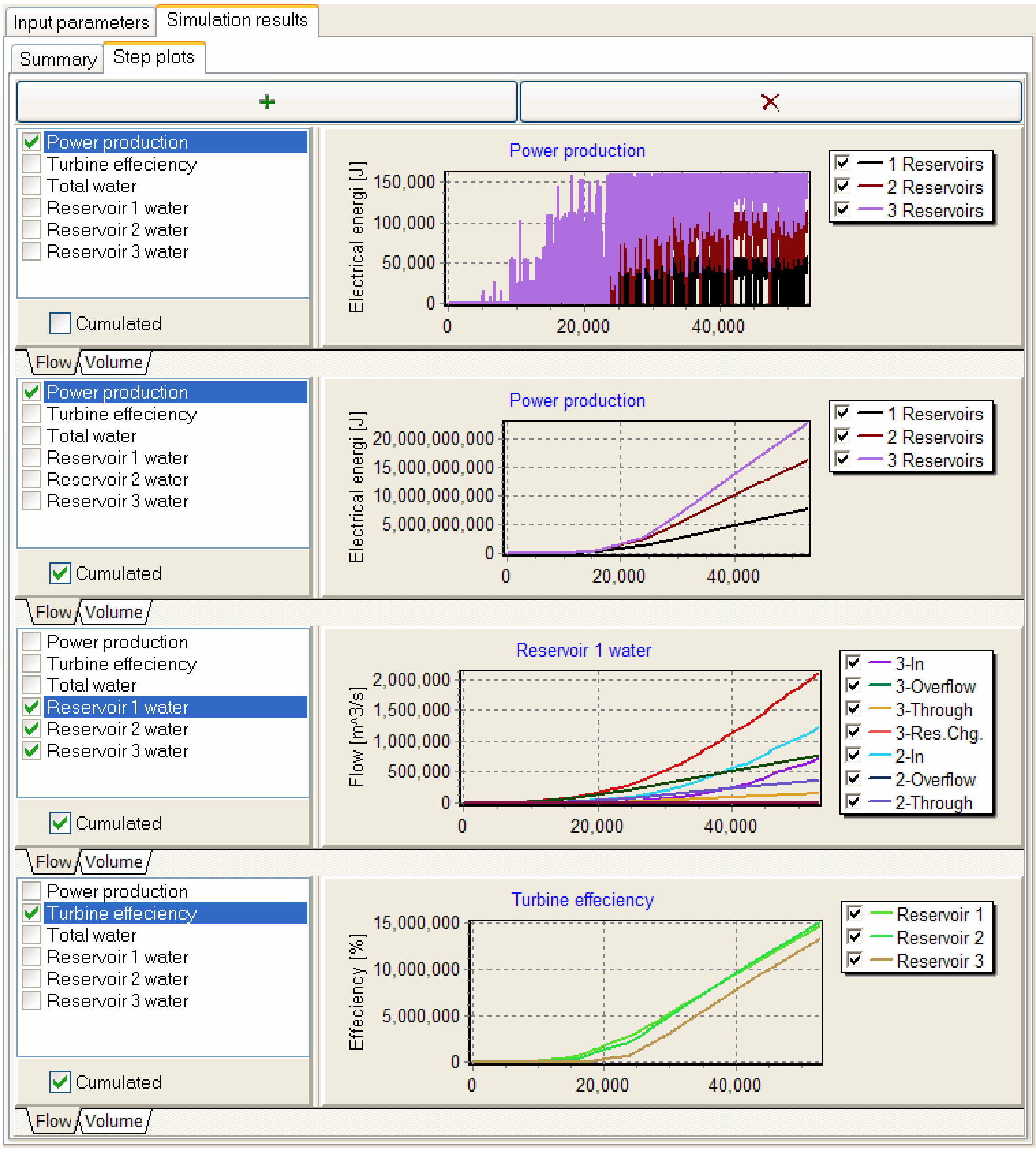


Figure 8, Step plots.

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