

.conf2015

# Splunking Wind Turbines and Keeping the Earth Green

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splunk>

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# Agenda

1

THE  
CUSTOMER

WHO ARE  
THEY?

2

THE USE  
CASE

WHAT DID  
THEY NEED?

3

THE  
JOURNEY

WHAT DID WE  
DO?

4

A CUSTOM  
SOLUTION

WHAT DID WE  
CREATE?

5

HOW WE  
WON

KEY  
TAKEAWAYS

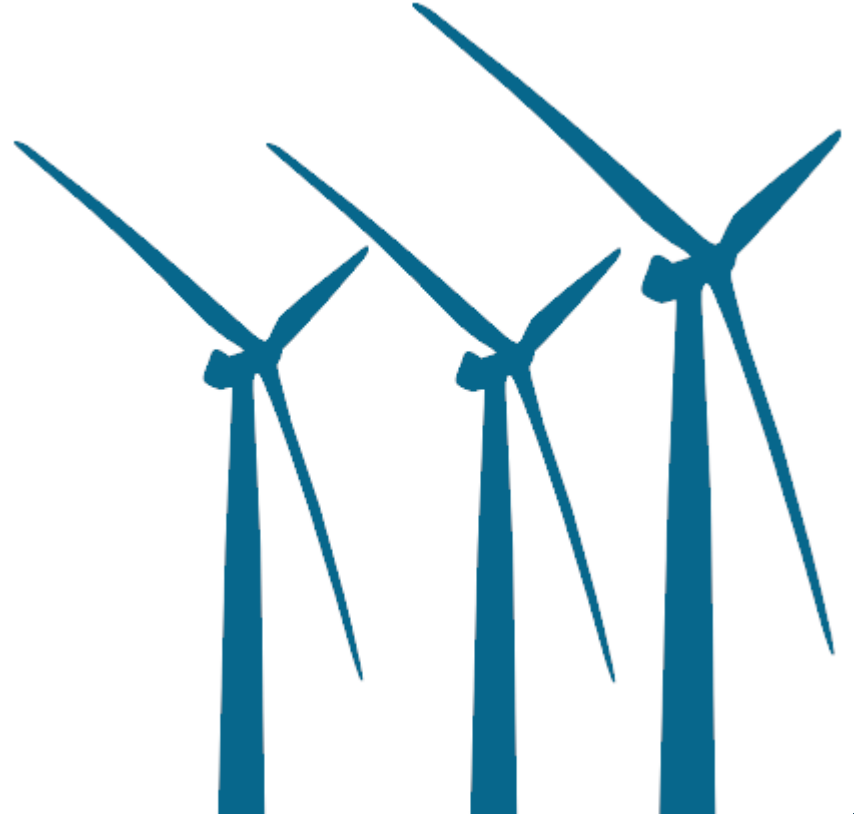
# KONČAR Electrical Industry Inc.

- Founded 1921
- Companies and representative offices abroad in: *Switzerland, Bosnia and Herzegovina, the Russian Federation and Serbia*
- 3800 employees
- Sales revenue: €332 million
- Export: 50%



# Wind Park – Pometeno Brdo

- Location: Dugopolje (near Split)
- 16 wind turbines, built completely by Končar
- Total power: 17,5 MW
- Total investment: €29 million
- 14 Končar companies and 15 partners
- 80% parts from Croatia



# The Challenge

- Wind turbines generate a huge amount of data (approx. 2 million events per day) about their availability, production of energy and energy losses
- Končar previously stored this data in a SQL database and used complex external applications to produce reports as well as to proactively alert when a particular wind turbine is having issues
- This became more and more cumbersome as the amount of historical data kept growing

# The Challenge

## Monitoring requirements:

- Calculation of availability
- Total energy production & losses
- Daily and monthly PDF reports
- Proactive detection of issues in wind turbines

## Issues:

- Algorithm for calculation of availability
  - Iterative algorithm (very slow)
- Report generation time
  - Daily reports: ~1h
  - Monthly reports: ~12h (!!!)
- Central storage
  - SCADA
  - Microsoft SQL Server 2008 (2 million events daily)

# The Journey

Existing customer  
came to us with a  
new problem

POC uncovered the  
need for a custom  
solution

Built custom app and  
custom reporting  
module

Happy customer,  
looking to extend  
usage!



# What We Built

## Application inputs



- Database
  - Microsoft SQL Server 2008
- XML configurations
  - Custom XML configurations for calculations

# What We Built

## Database inputs



- Microsoft SQL Server 2008
- Unable to use Splunk DB Connect
  - Primary key composed of two columns  
Time (to seconds) and MS (milliseconds)
- Developed our own Java JDBC agent

# What We Built

## Custom database connector



- Connection parameters
  - host, port, database, username and password
- Primary keys
  - Name
  - Type (timestamp or number)
- SQL query
  - ... WHERE (a.Time='<math>\\$time\\$</math>' AND a.Ms '<math>\\$ms\\$</math>') OR a.Time '<math>\\$time\\$</math>')
- Encrypts configuration with a private RSA key

# What We Built

## Custom database connector



- Scripted input
  - iteratively, every 30 seconds

```
[script://$SPLUNK_HOME/etc/apps/koncar/bin/database_agent.sh]
interval = 30
index = koncar
sourcetype = koncar
```

- Collect inputs from standard output
  - Key-value format (field=value)

```
2015-02-16 23:59:59.346 Value=1.0 Quality=192 DataKeyId=135
```

- Store maximum primary key pair values for the next run

# What We Built

## XML configuration inputs



- Custom XML configurations for calculations
- Parsers as custom Python controllers
- Lookup files as output

Konfiguracija za raspoloživost

Generiraj

**Configuration generated successfully**

# What We Built

## XML configuration inputs



```
<?xml version="1.0" encoding="utf-8"?>
<RaspolozivostConfigBean xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <CommandTimeout>1200</CommandTimeout>
  <BeginningOfTime>
    <Day>22</Day>
    <Month>2</Month>
    <Year>2012</Year>
  </BeginningOfTime>
  <GoodQualities>
    <int>200</int>
    <int>192</int>
    <int>100</int>
  </GoodQualities>
  <Sources>
    <SourceBean>
      <Name>VA1</Name>
      <Groups>
        <GroupBean>
          <Name>System OK</Name>
          <Priority>0</Priority>
          <DataKeys>
            <int>22</int><!-- Wind Power Plant.Info.SEQ_WORD:Connection.5.6 -->
            <int>15</int><!-- Wind Power Plant.Info.SEQ_WORD:Production.5.7 -->
          </DataKeys>
          <Availability>true</Availability>
        </GroupBean>
      </Groups>
    </SourceBean>
  </Sources>
</RaspolozivostConfigBean>
```

# What We Built

## XML configuration inputs



### Konfiguracija za raspoloživost

#### Good qualities

	GoodQuality ↕
1	100
2	192
3	200

#### Raspoloživost konfiguracija

GroupId:  Group:  GroupName:

Description:  Color:

« prev **1** 2 3 4 5 6 7 8 9 10 next »

	GroupId ↕	Group ↕	GroupName ↕	Priority ↕	Availability ↕	DataKeyId ↕
1	2	VA1	VA1 sequence and brake	1	1	12
2	2	VA1	VA1 sequence and brake	2	1	13
3	2	VA1	VA1 sequence and brake	1	1	14
4	2	VA1	VA1 sequence and brake	0	1	15
5	2	VA1	VA1 sequence and brake	2	1	17

# What We Built

## Calculating availability



- Inputs
  - **Groups** (System OK, Service, Error, ...)
  - **States** (Error → Emergency brake, Grid brake, ...)
- Multiple states can be active at the same time
- Custom python search command
- Summary indexes
  - Hourly statistics and calculation states





# What We Built

## Calculating availability



- Read group activity from previous hour
  - `index=availability sourcetype=activity earliest=-1h@h latest=@h | table ...`
- Calculate availability
  - `index=koncar earliest=-1h@h latest=@h | sort 0 _time | table ...`
- Store results
  - Group duration  
`2015-02-17 13:00:00 WindTurbine="VA10" Group="System OK" Duration=2934000`
  - Group activity  
`2015-02-17 14:00:00 WindTurbine="VA10" Group="Error" States="2000,2490"`

# What We Built

## Updating events



### Modifikacija zapisa

Vrijeme zapisa (godina-mjesec-dan sat:minuta:sekunda.milisekunda)

2015 - 02 - 16 18 : 09 : 01 . 300

Parametri zapisa

GroupId: 2 DataKeyId: 12

Pretraga

### Zapis

Zapis ↕

1 Vrijeme="2015-02-16 18:09:01.300" Time=1424106541.000 Ms=300 InsertedOn="2015-02-16 18:10:28.0634813" Value=0.0 Quality=192 DataKeyId=12 DataKey="Wind Power Plant.Info.SEQ\_WORD:Yaw and run.5.3" GroupId=2 GroupName="VA1 sequence and brake"

### Promijena vrijednosti zapisa

Value: 1

Promijeni

### Rezultat akcije

Datum novog proračuna raspoloživosti (godina-mjesec-dan)

- -

Promijeni

# What We Built

## Updating events



- Find entry
  - `index=koncar earliest="$m/d/y:h:m:s$" "$y-m-d h:m:s.ms$" GroupId="$gid"`  
`$" DataKeyId = "$dkid$" | head 1 | table _raw`
- Delete entry
  - `index=koncar earliest="$m/d/y:h:m:s$" "$y-m-d h:m:s.ms$" GroupId="$gid"`  
`$" DataKeyId = "$dkid$" | delete`

# What We Built

## Updating events



- Save modified entry to unique filename that Splunk is indexing in batch mode

```
[batch://$SPLUNK_HOME/etc/apps/koncar/update]
```

```
index = koncar
```

```
sourcetype = koncar
```

```
move_policy = sinkhole
```

```
crcSalt = <SOURCE>
```

# What We Built

## Total energy production and losses



- Calculations based on stats commands

- Energy curve lookup

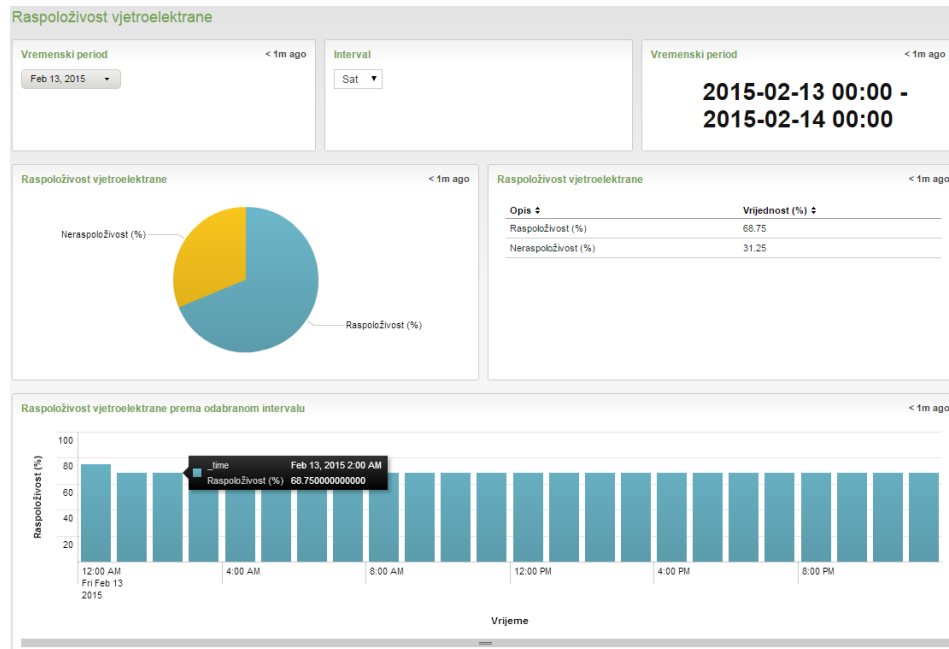
- Energy

- Losses

- Average wind speed in 1m intervals

- Summary indexing

- Hourly and daily statistics



# Custom .NET application



- A crucial part of this project was the ability to produce reports in their existing templates
- Now they can send the same reports to their existing customers
- We developed a custom external .NET application that relies on Splunk's SDK API
- Retrieve data and produce specific PDF and Excel reports in the format requested by the customer
- This allows the customer to generate reports from data stored in Splunk in any format they want
  - They simply need to generate a template which will be used by the developed .NET application

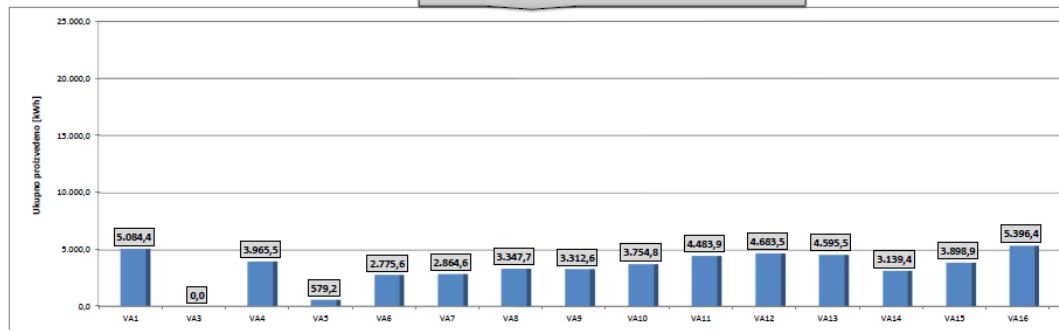
# Custom .NET application



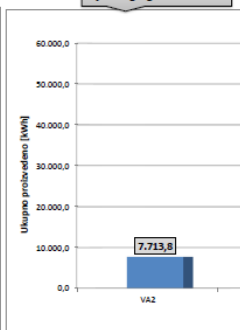
- Templates prepared in Excel
- Fetch summary data from Splunk
  - Splunk C# SDK
- Start Excel process in a background and fill template
  - Microsoft.Office.Interop.Excel
- Generate PDF from Excel template
- Send report to list of email addresses

VJETROELEKTRANA POMETENO BRDO		PROIZVODNJA I KORISNOST UZ REALNU RASPOLOŽIVOST		PROIZVODNJA UZ STOPOSTOTNU RASPOLOŽIVOST		DATUM		PROIZVODNJA S ION-a	
DATUM:	31.3.2015.	MOGUĆA:	74.446,5 kWh	$\eta = 0,80$	MOGUĆA:	84.831,3 kWh	$\eta = 0,70$	31.3.2015. 0:00	924622 kWh
UKUPNO PROIZVEDENO NA VE:	59.595,7 kWh	TEORETSKA:	72.508,58 kWh	$\eta = 0,82$	TEORETSKA:	82.386,5 kWh	$\eta = 0,72$	31.3.2015. 23:59	988272 kWh
		GUBICI MOGUĆE PROIZVODNJE:	10.934,8 kWh					UK/dan	63.650,0 kWh
		GUBICI TEORETSKE PROIZVODNJE:	9.877,9 kWh						

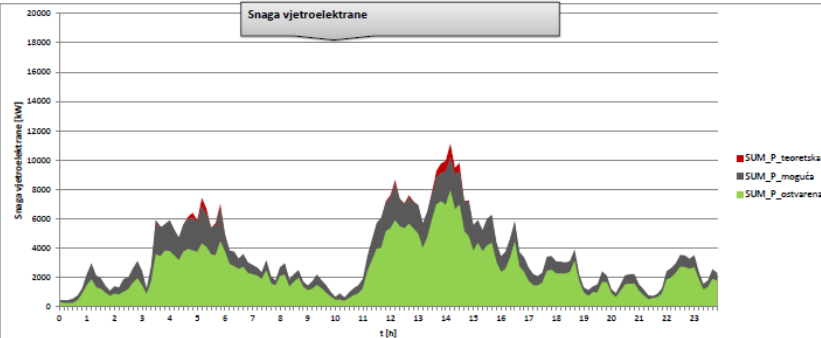
Ostvarena proizvodnja - Vjetroagregat 1 MW



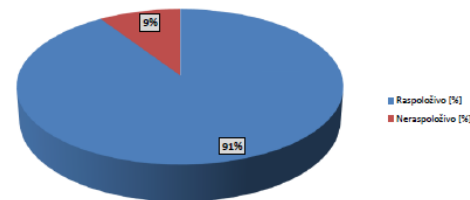
Ostvarena proizvodnja - Vjetroagregat 2.5 MW



Snaga vjetroelektrane



Raspoloživost vjetroelektrane



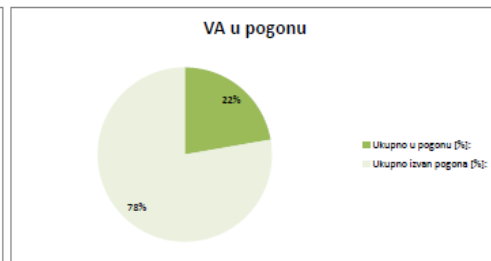
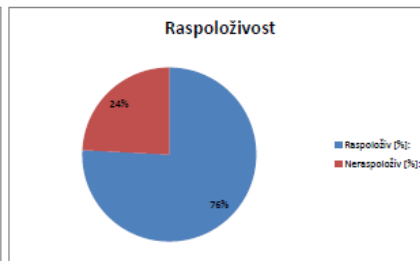
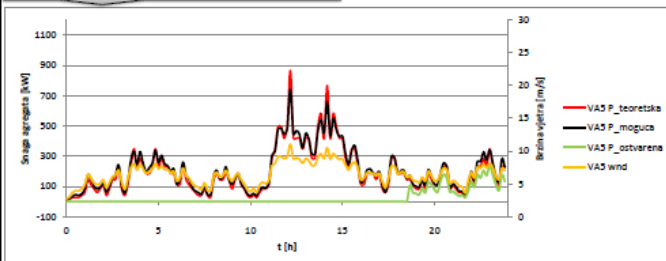


VJETROAGREGAT:	VA5
DATUM:	31.3.2015.
UKUPNO PROIZVEDENO NA VA:	579,2 kWh
RASPOLOŽIV [%]:	75,82
NERASPOLOŽIV [%]:	24,18

PROIZVODNJA I KORISNOST UZ REALNU RASPOLOŽIVOST			
1) MOGUĆA:	913,8 kWh	$\eta = 0,63$	
2) TEORETSKA:	849,1 kWh	$\eta = 0,68$	
GUBICI MOGUĆE PROIZVODNJE:	0,0 kWh		
GUBICI TEORETSKE PROIZVODNJE:	3.880,2 kWh		

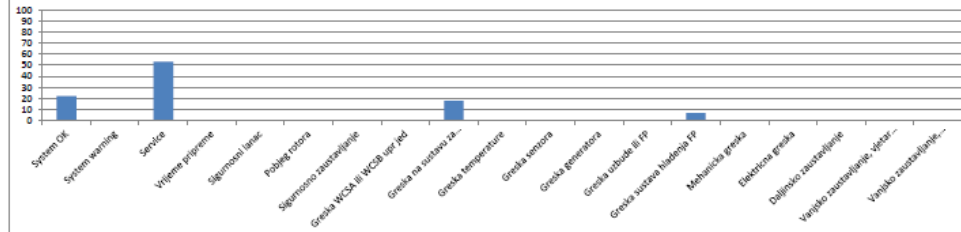
PROIZVODNJA I KORISNOST UZ STOPOSTOTNU RASPOLOŽIVOST			
MOGUĆA:	5.061,1 kWh	$\eta = 0,11$	
TEORETSKA:	4.729,3 kWh	$\eta = 0,12$	

Teoretska, moguća i ostvarena snaga, te brzina vjetra



System OK	System warning	Service	Vrijeme pripreme	Sigurnosni lanac	Pobijeg rotora	Sigurnosno zaustavljanje	Greska WCSA ili WCSB upr jed	Greska na sustavu za zakretanje lopatica	Greska temperature	Greska senzora	Greska generatora	Greska uzbude ili FP	Greska uzbude ili FP	Greska sustava hlađenja FP	Mehanička greska	Električna greska	Daljinsko zaustavljanje	Vanjsko zaustavljanje, vjetar preslab	Vanjsko zaustavljanje, nepovoljni vanjski uvjeti
22,27	0	53,07	0,48	0,04	0	0	0	17,65	0	0	0	0	0	6,49	0	0	0	0	0

Raspoloživ [%]:	75,82
Neraspoloživ [%]:	24,18
Ukupno u pogonu [%]:	22,27
Ukupno izvan pogona [%]:	77,73



# Key Takeaways

- Machine data is more than just IT (IoT is really here)
- Splunk is a flexible tool
  - Take advantage of customizations through search commands or external Python controllers
- Use this flexibility to implement exactly what the customer needs
  - If Splunk's built-in reporting is limited, with SDK API sky's the limit



# Key Takeaways

- With Splunk, the time to generate reports has been dramatically reduced
- Daily report
  - From one hour to less than ten seconds
- Monthly report
  - From twelve hours to less than ten seconds (yes, 4.000 times faster with Splunk)
- The customer can now run yearly reports
  - Something they could not even dream about before



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?

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THANK YOU

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