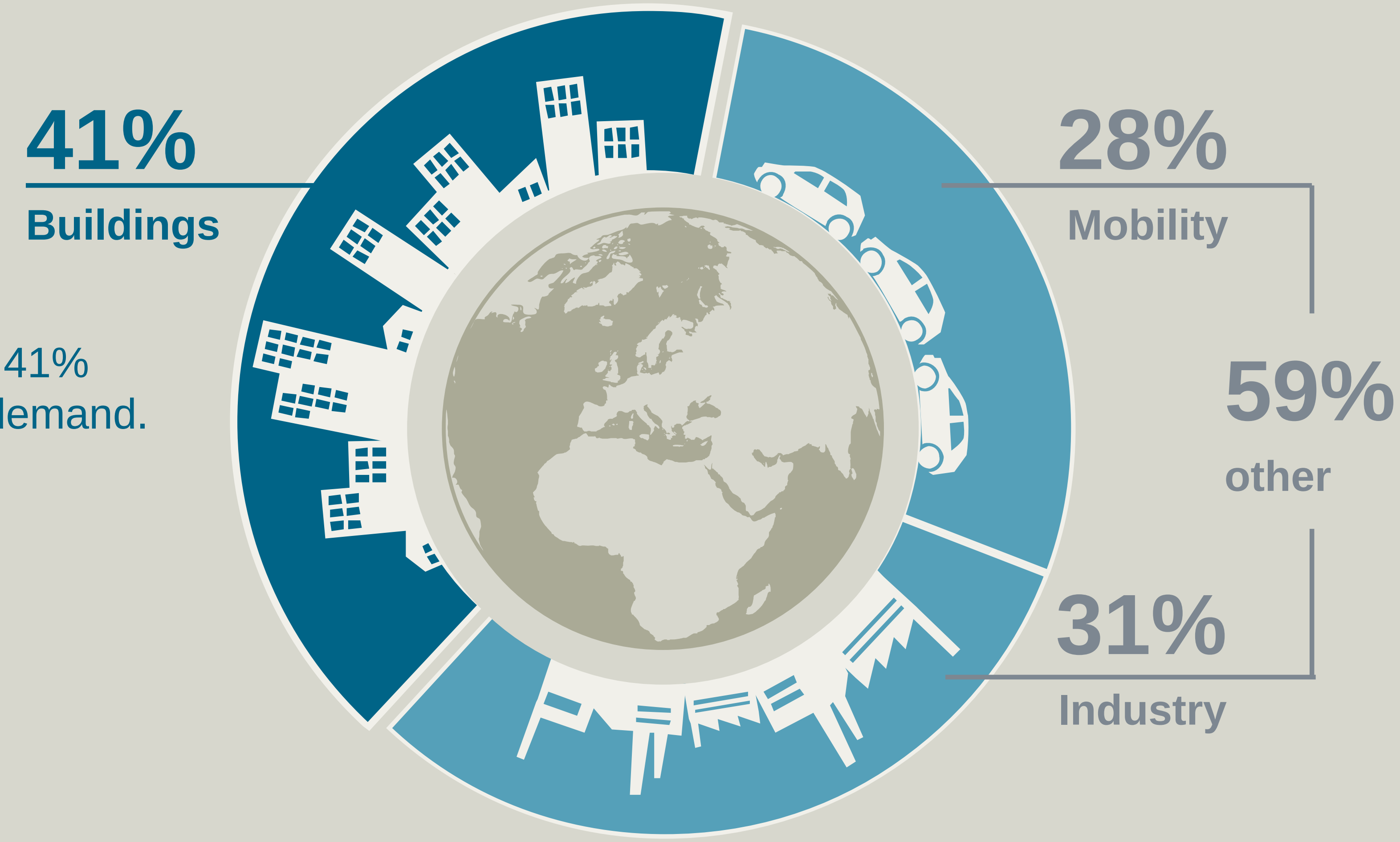
Demand Flow® Concept

Water-cooled, Central Chilled Water Plants
Save energy & operational cost – Payback 1 to 4 years – Performance Guaranteed

Agenda

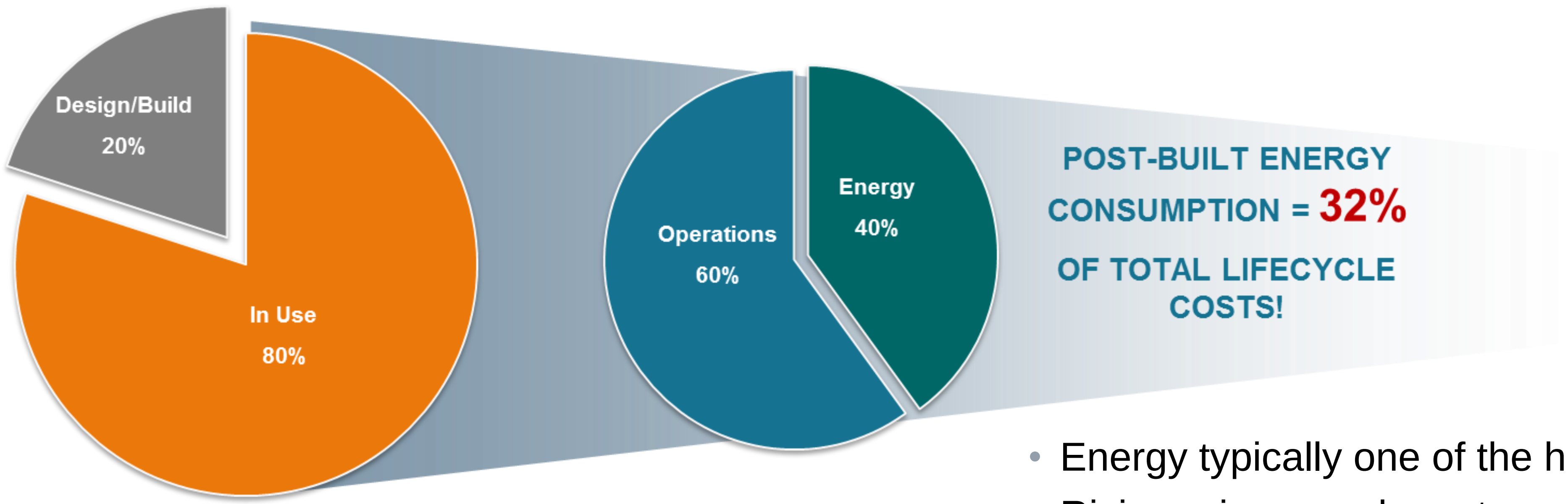
- Building Life Cycle
- Market Driving Factors
- Overview of Chilled Water System Optimization
- Overview of Demand Flow Concept
- Statistical Model
- Case Studies
- Discussion

Buildings are a key factor for the environment, climate and energy worldwide ...



Buildings account for 41% of the global energy demand.

Building Lifecycle Costs



- Energy typically one of the highest operating costs
- Rising prices can have tremendous impact on bottom line
- Impacts core business as budget/investments are prioritized

*International Energy Association, auf weltweiter Basis, im Jahr 2002 / ** Dena Congress, Berlin, 2008 / *** „Global Mapping of Greenhouse Gas Abatement Opportunities up to 2030", Building Sector deep dive, June 2007, Vattenfall AB, basiert auf Information von IEA, 2002, % der weltweiten Treibhausgasemissionen; Total 40 Gt CO_2e

Market Driving Factors –
Chilled Water System Optimization

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Global Factors

- Volatile energy prices and rising demand
- Legislative landscape that requires action
- Concerns for occupant comfort and safety
- Growing interest in sustainability issues

Internal Factors

- Pressure to lower operating costs
- Reducing hot calls and improve comfort
- Increased system reliability
- Staffing pressures
- Need for simpler system operation

Overview: Why Chiller Plant Optimization?

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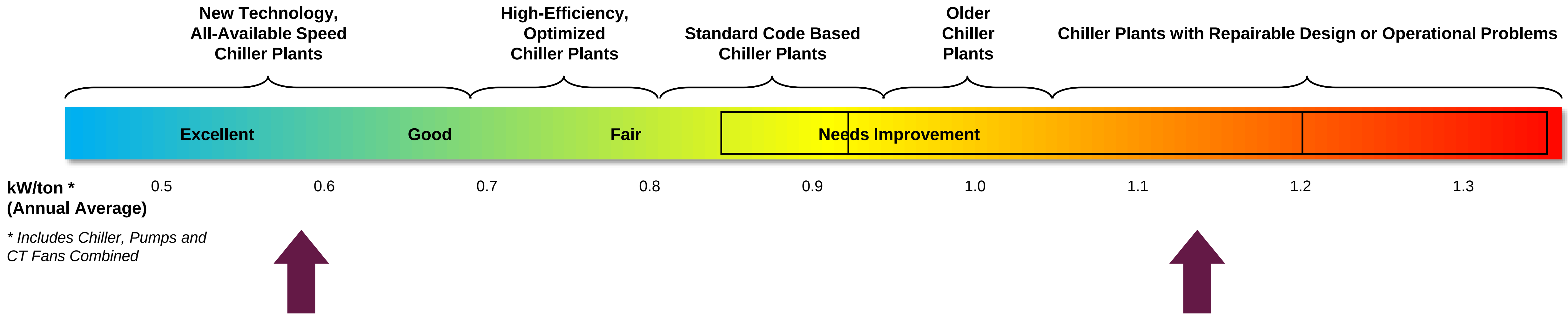

** Includes Chiller, Pumps and CT Fans Combined*

Post-Optimization
(Annual Average can range from 0.5 – 0.75 kW/Ton)

Pre-Optimization
(Annual Average typically $\geq$ 0.8 kW/Ton)

Source: "All Variable Speed Chiller Plants", ASHRAE Journal, September 2001

Overview: Why Chiller Plant Optimization?

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New Technology, All-Available Speed Chiller Plants	High-Efficiency, Optimized Chiller Plants	Standard Code Based Chiller Plants	Older Chiller Plants	Chiller Plants with Repairable Design or Operational Problems

kW/ton *
(Annual Average)

0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3

** Includes Chiller, Pumps and CT Fans Combined*

Post-Optimization
(Annual Average can range from 0.5 – 0.75 kW/Ton)

Pre-Optimization
(Annual Average typically
≥ 0.8 kW/Ton)

Post
3300T peak chiller plant optimized to **0.7 kW/Ton**

Estimated Savings**

~ AED1,000,000/yr

Pre
3300T peak chiller plant at **0.96 kW/Ton**

****Assumptions:** AED 0.45/kWh, Dubai Conditions

Source: "All Variable Speed Chiller Plants", ASHRAE Journal, September 2001

What is Chilled Water System Optimization?

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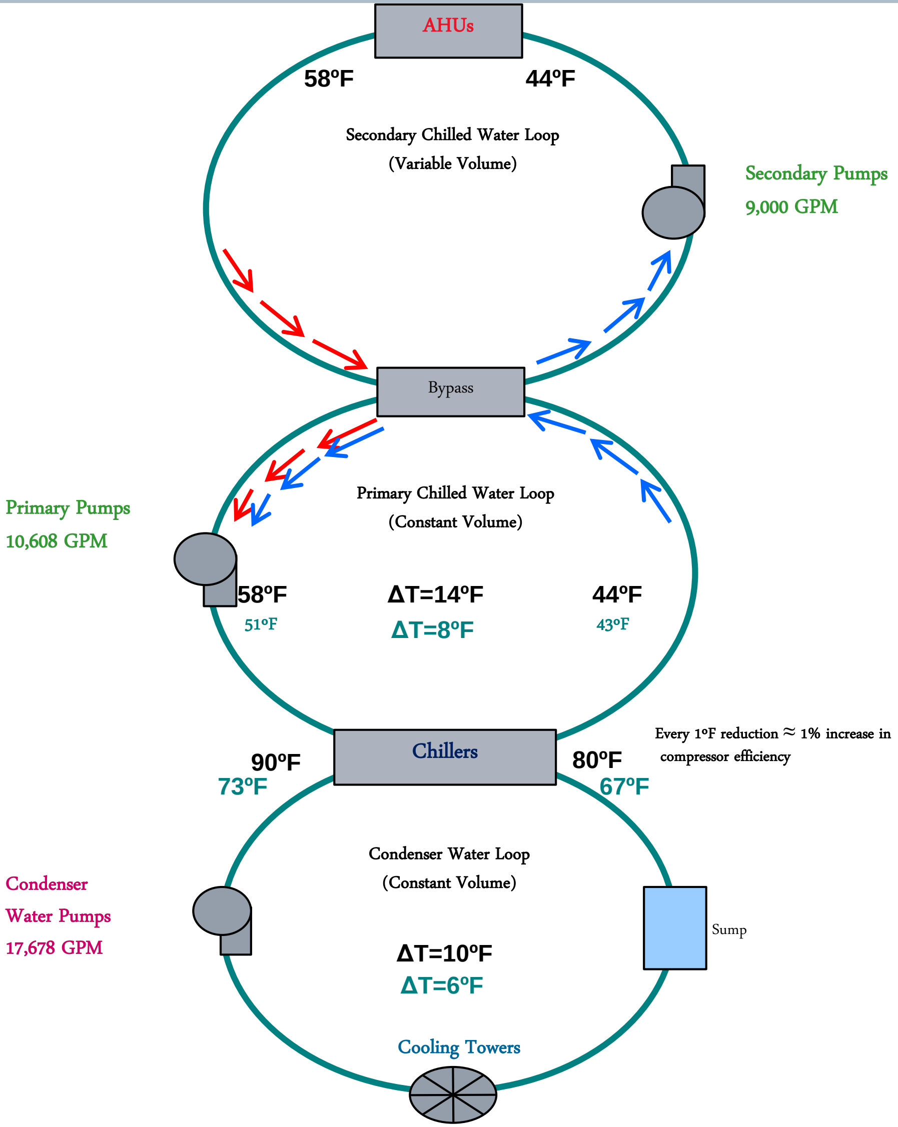

Fundamental energy consuming sub-systems that influence deliverable capacity:

1. Chillers
2. Chilled Water Pumping
3. Condenser Water Pumping
4. Cooling Tower Fans
5. Air Side

These 5 subsystems are interdependent

- Energy and deliverable capacity are interdependent
- Often "conservation methods" reduce deliverable capacity
- Often energy conservation methods result in a "transfer of energy" among the 5 subsystems
- Most chilled water systems are plagued with "Low Delta-T Syndrome“
- Comfort is often sacrificed to obtain efficiency.
- Continuous full speed operation of some plant equipment resulting in decreased equipment life

Traditional Optimization method vs. Demand Flow Strategies

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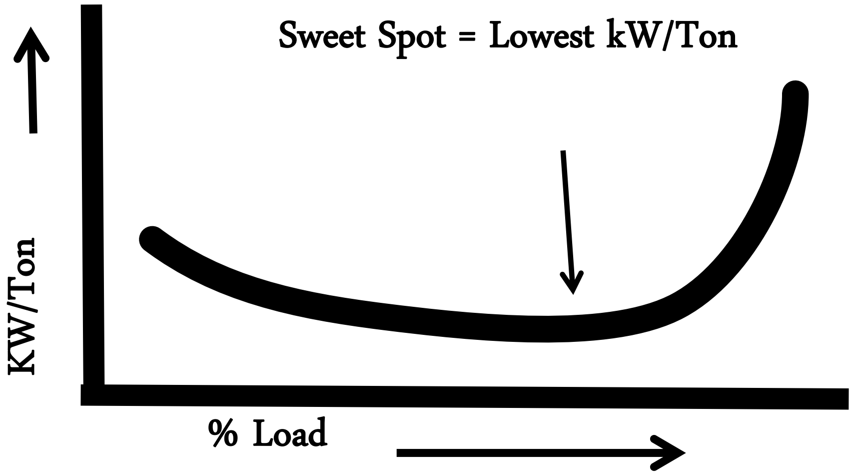
Out-dated Methods of Optimization

- Reset chilled water temperature up
- Chillers sequenced via a database of load profiles
- Attempts to find a "sweet spot"
- **Only focuses on optimizing the *chiller***

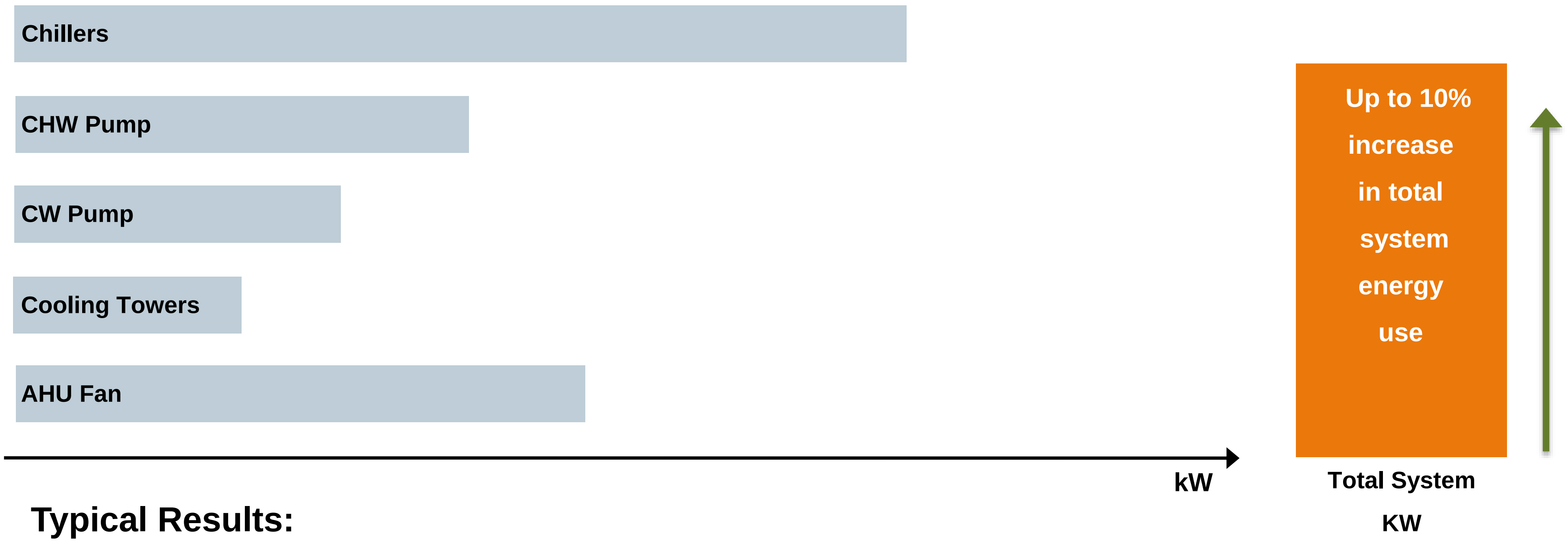
Demand Flow Holistic Optimization Solution

- Widens "sweet spot" = increased efficiency throughout the entire tonnage range
- Increased deliverable tonnage leads to more redundancy
- Fewer start/stops = less wear & tear
- Building load defines system pressure set points
- **Focus on optimizing the *Whole System***



Typical "Non-Demand Flow" Chiller Plant optimization Project

Effects of Chilled Water Reset on Total System Energy - Raising Chiller Water Temp



Typical Results:

- Warmer CHW increases CHW Pumping Energy and AHU Fan Energy in VAV systems
- Compromised occupant comfort
- Decreased humidity control

Net Energy Effect of Demand Flow

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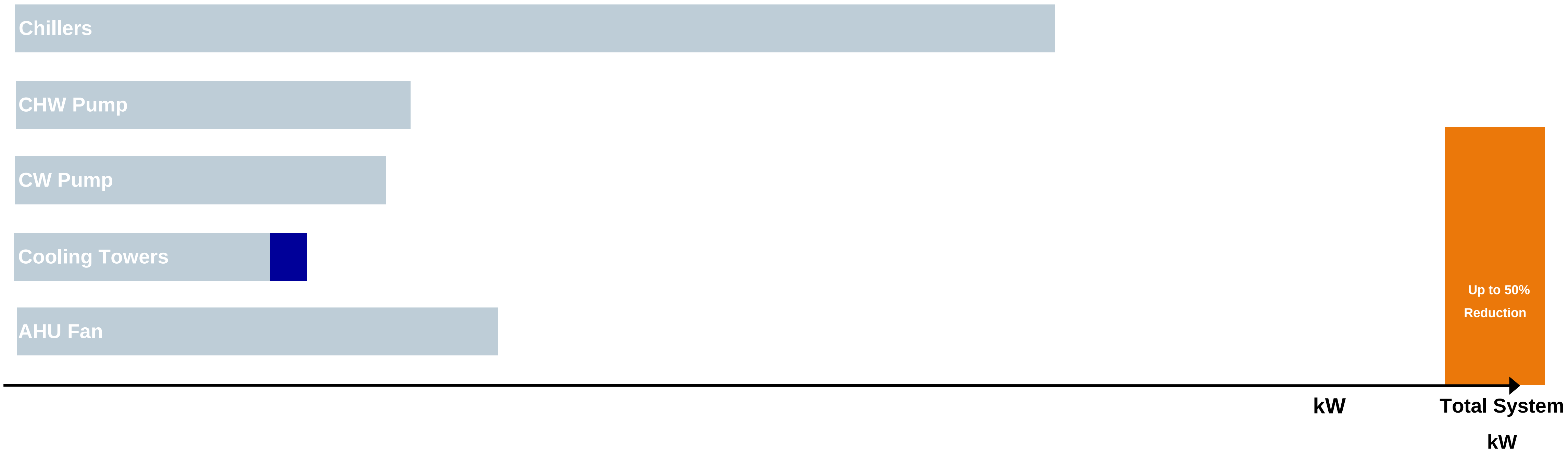
Demand Flow Optimization Project



Primary Benefits

- Reduced energy consumption and greater performance (Up to 50% reduction of total kW)
- Extended equipment life
- Simplified system operation
- Improved indoor environmental quality
- 1-4 year Simple Paybacks, 25%+ IRR

The Demand Flow® Concept - What's Different

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- VFDs installed on all Chilled Water and Condenser Water Pumps and Cooling Tower Fans
- Water Flow Varies thru Chiller Evaporator and Condenser
- Virtually no Chilled Water/Condenser Water bypass
- Optimize Pressure and Temperature set-points based on system dynamics
- VFDs are **<u>not</u>** required on the Chillers
- Pre and Post Measurement and Verification

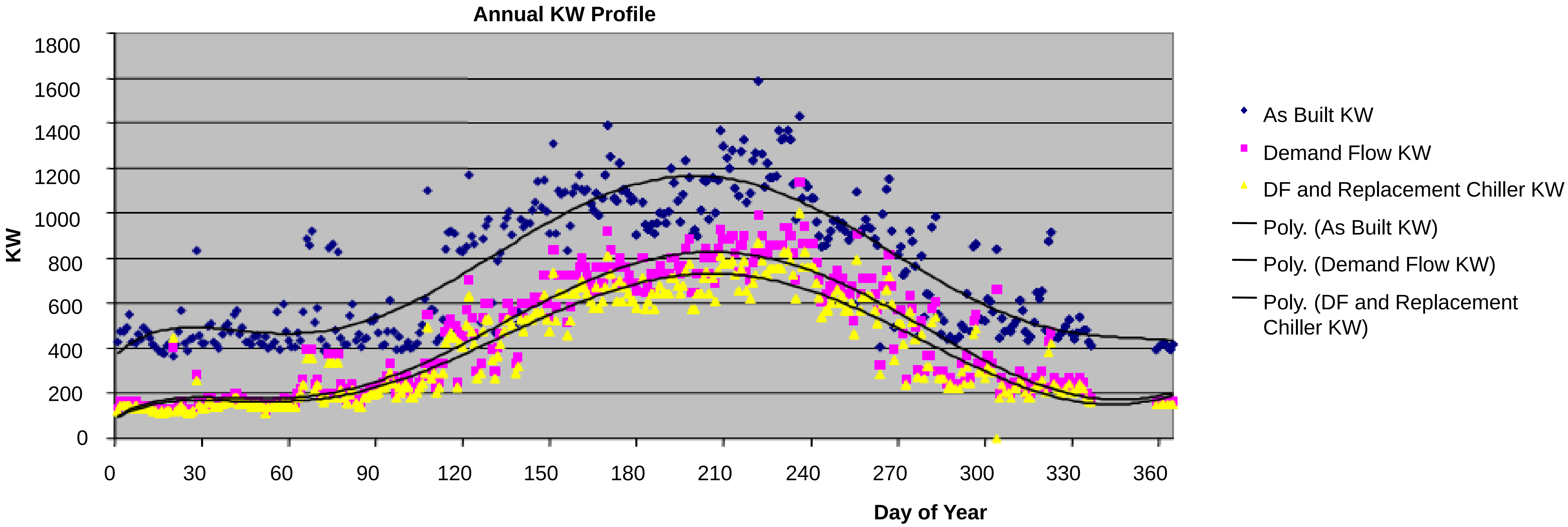
The Demand Flow® Concept - System Effects

- Increases system deliverable tonnage (where low Delta-T is present)
- Manages chiller "Lift", effectively eliminates refrigerant flow issues at low load conditions
- Stable Chiller Refrigerant loop performance at virtually all tonnage loads.
- Typically up to 50% total Chilled Water System energy savings with 1-4 year simple payback.
- Reduced run-time = less maintenance
- Improved indoor environmental quality - Occupant comfort is not sacrificed to provide energy savings

Demand Flow results in significant energy savings and improved comfort

Statistical Energy Modeling

Typical base-line energy consumption vs. optimized energy consumption



Case Studies in Dubai

DAFZ Main Plant performance

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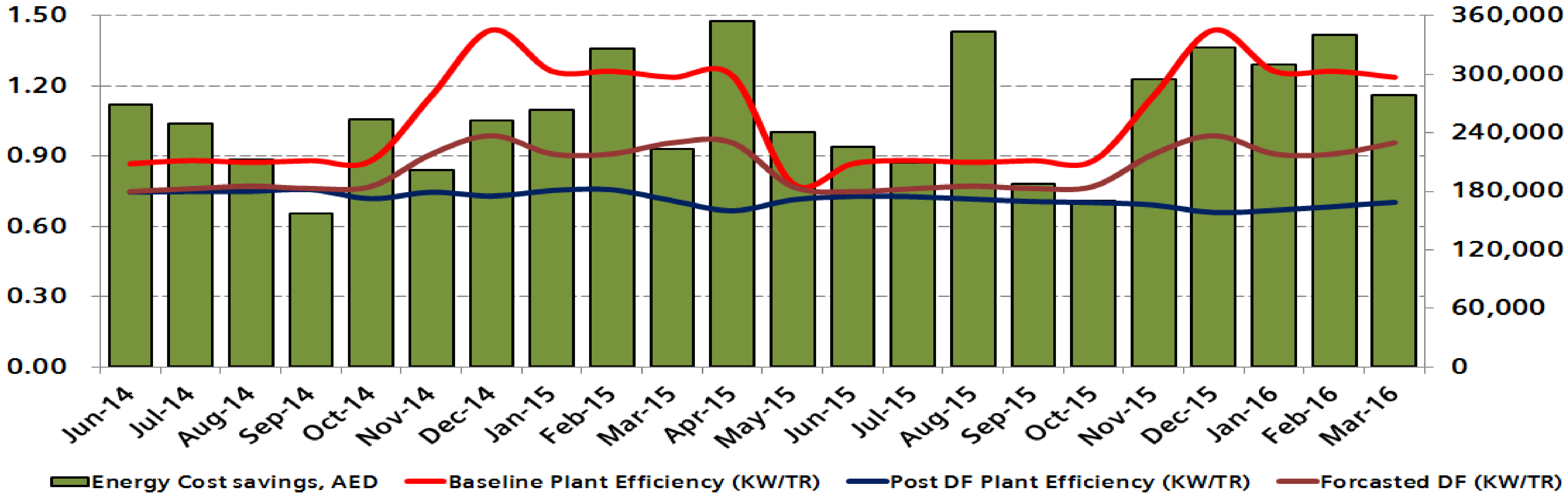
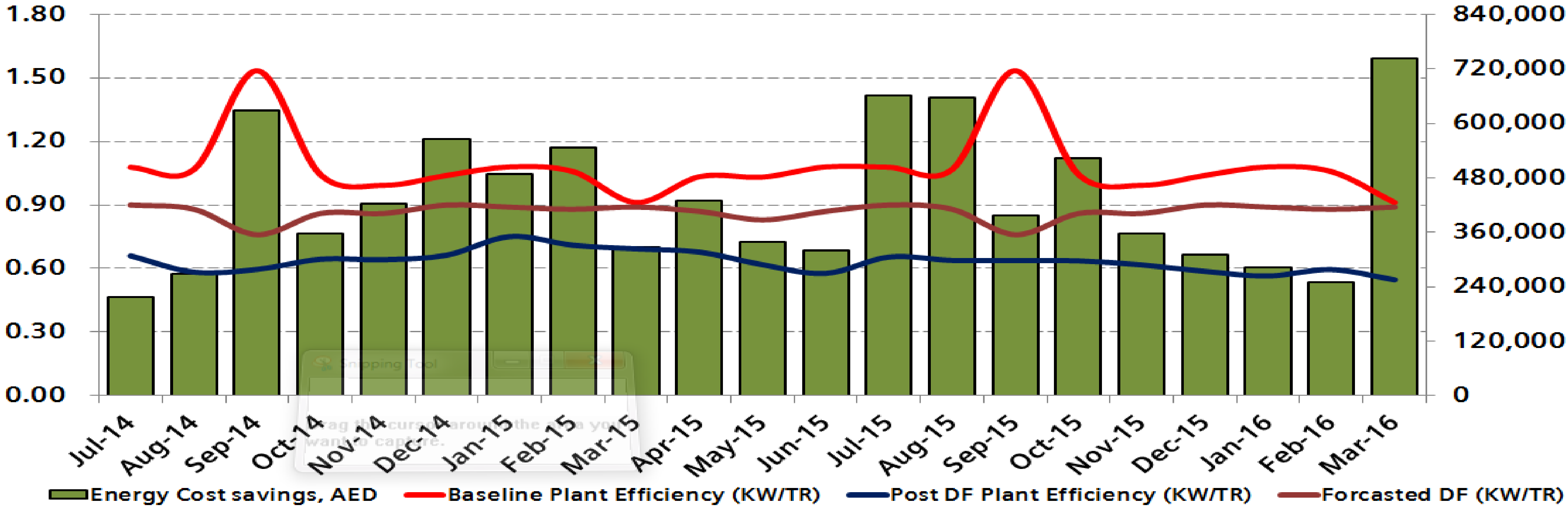


- **The project includes 12 office buildings, HQ Building and Chiller Yard**
- **Plant Size – 11,000TR (6 nos. Water Cooled Chillers)**

- **Average annual plant efficiency before Demand Flow implementation was 1.06 KW/Ton**
- **Average Plant efficiency for period June 14 - Mar 16 was 0.721 KW/Ton**
- **This has resulted in more than 30.0% savings for the period**
- **The actual project payback period was less than 1 year**

WAFI DCCP 1 Plant performance



- The project includes a Shopping Mall, Residences , 5 Star Hotel, Souq and Health/Leisure facilities
- Plant Size – 6075TR (3 nos. Water Cooled Chillers)

- Average annual plant efficiency before Demand Flow implementation was 1.055 KW/Ton
- Average Plant efficiency for period July 14 - July 16 was 0.63 KW/Ton
- This has resulted in more than 40.0% savings for the period
- The actual project payback period was less than 1 year

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Ingenuity for life

Thank you for your attention!